PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicants: Charles J. LONGACRE, et al.

Serial No: 10/637,139 | Group Art Unit: 3679

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Att. Docket No.: S1097/20001 | Confirmation No.: 3431

For: Joint Restraint Assembly

APPEAL BRIEF PURSUANT TO 37 CFR §41.37

Mail Stop Appeal Brief-Patents
Commissioner for Patents
Board of Patent Appeals & Interferences
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This brief is being timely filed, under the provisions of 37 CFR §41.37.

REAL PARTY IN INTEREST

Sigma Corporation is the real party in interest and whose assignment is recorded at Reel/Frame: 014393/0526.

RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to the Appellant, or the Appellant's legal representatives, that will directly affect or be directly affected by, or have a bearing on, the Board of Patent Appeals and Interferences' decision in the pending appeal.

STATUS OF CLAIMS

Claims 1-14, 19 and 20 are pending in this application. These claims were rejected in a Final Rejection dated January 27, 2006. Claims 15-18 were previously canceled due to a restriction requirement.

Claims 1-14, 19 and 20 are being appealed, and a copy of these claims is included in the Claims Appendix accompanying this brief.

STATUS OF AMENDMENTS

No amendments have been filed subsequent to the Final Rejection dated January 27, 2006.

SUMMARY OF CLAIMED SUBJECT MATTER

The subject invention of Claim 1 is directed to a joint restraint assembly for connecting pipe ends together, or to other objects, which includes a body 2 encircling the pipe 14 (see "Evidence Appendix," Present application, Figs. 1-3). The body 2 has a plurality of cavities 4 adjacent the pipe 14 with a segment 6 configured to fit into each cavity 4 (Present application, Fig. 2). One or more threaded bores 5 are disposed through the body 2 into each cavity 4. A threaded bolt 7 extends through each threaded bore 5 to engage the segment 2 in that cavity 4, and to pre-load the segment 2 against the pipe 14 when assembled thereon (see Fig. 4). As mechanical or pressure loading increases, which tends to pull the pipe 14 out of the restraint assembly, the corner 12 of the segment 6 loads against interior corner 13 of the cavity 4 to serve

as a pivot, and edge 16 of the segment 6 penetrates deeper into the pipe surface 15 (see Fig. 5; see page 13, lines 13-16 of present application), and the segment 6 disengages from contact with the threaded bolt 7 (see Fig. 5, end of bolt 7 is no longer in contact with segment 6). Therefore, the depth of penetration of the segment edge 16 into pipe surface 15, and thus the ability to resist pipe pull-out load 17, is directly proportional to the mechanical and/or internal pressure loading applied to the pipe – i.e., the mechanism is "self-actuating." Under these conditions, the threaded bolt 7 no longer contributes to the ability of the joint restraint assembly to resist the pull-out load 17, and the threaded bolt 7 is not subjected to pull-out load 17 or damage therefrom; note in Fig. 5 that the rounded end of the threaded bolt 7 is no longer in contact with the segment 6. Thus, the self-actuating feature of the segment 6 operates independently of the threaded bolt 7. (Present application, page 13, lines 27-page 14, line 4).

The subject invention of Claim 9 is directed to a joint restraint assembly for connecting pipe ends together, is similar to the subject invention of Claim 1 but instead of using the segment 6, the segment 6A (Present application, Figs. 7-7a) uses a cam-shaped member. In particular, the segment 6A comprises a cam-shaped member which is initially pre-loaded via the threaded bolt 7, as discussed previously with regard to segment 6. As the mechanical and/or internal pressure loading increases, and relative movement occurs between the pipe and the restraint assembly, the corner 12 of segment 6A loads against interior corner 13 of the cavity 4, and a cam surface 16A rotates against the pipe surface 15 and transfers the load. Again, this action occurs independently of the threaded bolt 7. Similarly, the segment 6B (see Fig. 7a) comprises a cam-shaped member having a surface texture 16B (e.g., knurled surface) that engages the pipe surface 15. As the mechanical and/or internal pressure loading increases, the corner 12 of the segment 16B loads against the interior corner 13 of the cavity 4 to serve as a pivot, and the textured cam surface 16B

of the segment 6B rotates against, and penetrates, the pipe surface 15. Again, this action occurs independently of the threaded bolt 7. Thus, it should be understood that the self-actuating segment of the present invention can be achieved using different segment configurations that are (1) pre-loaded by the threaded bolt 7 to contact the pipe surface 15 and (2) that engage the pipe surface 15 and body 2 to provide resistance to pipe pull-out in proportion to the mechanical and/or internal pressure loading applied to the pipe, independent of the threaded bolt. (Present application, page 15, line 11 to page 16, line 2).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Whether Claims 1-7, 9-14 and 19-20 are unpatentable under 35 U.S.C. §102(b) based on U.S. Patent No. 6,173,993 (Shumard, et al., hereinafter "Shumard").

2. Whether Claim 8 is unpatentable under 35 U.S.C. §103(a) as being unpatentable over Shumard in view of U.S. Patent No. 4,848,808 (Pannell, et al., hereinafter "Pannell").

ARGUMENT

1 (a). THE EXAMINER ERRED IN CONCLUDING THAT SHUMARD SHOWS ALL THE ELEMENTS OF CLAIMS 1-7 AND 19

In the Final Rejection dated January 27, 2006, the Examiner finally rejected Claims 1-7 and 19 under 35 U.S.C. §102(b) asserting Shumard provides all the elements of Claims 1-7 and 19. Appellant submits that the Examiner has failed to show how Shumard anticipates the present invention as discussed below for the indicated claims.

Claim 1

The Examiner finally rejected Claim 1 as follows:

> In regards to claim 1, Shumard, et al disclose a joint restraint assembly (10) comprising:
>
> a body (14) encircling the pipe, with the body having a plurality of cavities (34) adjacent the pipe and at least one set of a corresponding plurality of threaded bores (20)

> disposed through the body, each threaded bore of the at least one set of a corresponding plurality of threaded bores being in communication with a respective cavity;
>
> a segment (40) disposed within each of the cavities in the body, the segment comprising a first portion (46) that contacts a surface (28) of the cavity and a second portion (52) that penetrates the outer surface of the pipe, the segment pivoting about the first portion, which maintains contact with the surface of the cavity throughout increasing mechanical or internal pressure load applied to the pipe, for driving the second portion deeper into the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, the segment resisting pipe pull-out in proportion to the increased mechanical or internal loading applied to the pipe increases. (Final Rejection, pp. 2-3).

The Examiner supplemented these assertions with the following:

> Applicant's arguments filed 11/2/2005 have been fully considered but they are not persuasive.
>
> Applicant argues that Shumard et al '993 do not disclose a segment disposed within each of the cavities in the body, the segment comprising a first portion that contacts a surface of the cavity and a second portion that penetrates the outer surface of the pipe, the segment pivoting about the first portion, which maintains contact with the surface of the cavity throughout increasing mechanical or internal pressure load applied to the pipe, for driving the second portion deeper into the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, the segment resisting pipe pull-out in proportion to the increased mechanical or internal pressure loading applied to the pipe increases. The Examiner disagrees. In Figure 5, Shumard et al clearly illustrates a segment (40) disposed within each of the cavities in the body, the segment comprising a first portion (46) that contacts a surface (28) of the cavity and a second portion (52) that penetrates the outer surface of the pipe, the segment pivoting about the first portion, which maintains contact with the surface of the cavity throughout increasing mechanical or internal pressure load applied to the pipe, for driving the second portion deeper into the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, the segment resisting pipe pull-out in proportion to the increased mechanical or internal pressure loading applied to the pipe increases. (Final Rejection, pp. 6-7).

Before discussing the errors of this rejection, a summary of Shumard (see "Evidence Appendix") is provided. The joint restraint device of Shumard operates on the wedge principle; in fact, one of its main components, 40, is a "wedge." In the Background section of the present application (page 3, line 30 to page 4, line 21), the concept of wedge-type restraint assemblies is discussed along with the problems involved with their use. As discussed in that section, the bolt shoulder slides against the restraint body whereas in the Shumard device the bolt slides against

the segment; but, in either case, these wedge-type restraint assemblies involve sliding motion against the bolt. In contrast, the present invention avoids the problems of these wedge-type restraints.

In particular, the Shumard joint restraint device 10 comprises a plurality of wedges 40 positioned in corresponding wedge pockets 34 of an annular body 14. A threaded bolt 32 (or 86) is then rotated/torqued to cause a first tooth 52, located on the bottom of the wedge 40, to bite into the pipe surface 56[1]. Increased mechanical or internal pressure loading causes the wedge 40 to move to the left (in Figs. 5-7) as the bottom surface 50 of the bolt 32 (or 86) slides up the wedge surface 48[2], pivoting the front surface 46 downward to drive a second tooth 54 (located on the bottom of the wedge 40) into the pipe surface 56[3]. ***However, as can be seen in Figs. 4-7 in Shumard, as the mechanical or internal pressure loading occurs and increases, the wedge 40 does not make contact with any corner, or even any sidewall[4], of the wedge pocket 34. Moreover, as the mechanical or internal pressure loading continues to increase, the Shumard device includes a stop 78 to prevent any further motion of the wedge 40***:

> After the second tooth 54 is embedded in the pipe surface, further pivoting of the wedge 40 is inhibited, but the wedge 40 may still slide relative to the bolt 32 until interference with the front edge 78 of the groove 48 <u>prevents further motion</u>. (emphasis added, Shumard, col. 7, lines 30-35).

However, this *<u>teaches away</u>* from the present invention whereby the segment edge 16 continues to dig deeper into the outer surface of the pipe (or the cam surface 16A or 16B continues to

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[1]Shumard, col. 6, lines 35-37; Also, from a practical standpoint, if these wedges 40 have any significant circumferential length, as illustrated in the figures (similar to dotted line 76 in Fig. 8), the threaded bolt 32 (or 86) would not be capable of embedding the first knife edge of the tooth 52 into a pipe surface comprising a ductile iron material, although it, perhaps, may be capable of penetrating PVC or plastic pipe; the same would be true of the second knife edge of the tooth 54. The forces provided by the bolt 32 (or 86) are just not sufficient to embed a long tooth (i.e., a tooth length corresponding to the length of dotted line 76) into the surface of ductile iron.

[2] Shumard, col. 3, lines 29-30.

[3] Shumard, col. 7, lines 22-30.

[4] In fact, Shumard states that once the second tooth 54 is embedded into the pipe surface, **<u>further pivoting of the wedge 40 is inhibited</u>**, although the wedge 40 may still slide relative to the bolt 32 until interference with the front edge 78 of the groove 48

rotate against the outer surface of the pipe, with regard to Claim 9) as the mechanical or internal pressure loading increases. Thus, these segment configurations provide resistance to pipe pull-out in proportion to the mechanical or internal pressure loading applied to the pipe.

Claim 1 of the present application specifies that the first portion (e.g., corner 12) of the segment 6 that contacts the cavity surface (e.g., interior cavity corner 13) **maintains that contact throughout increasing mechanical or internal pressure loading applied to the pipe**. This feature permits the second portion (e.g. segment edge 16) to pivot about the first portion as the mechanical loading increases, thereby providing resistance to pipe pull-out in proportion to this increased mechanical or internal pressure loading. In contrast, the front surface 46 (nor any other surface) of the wedge 40 of Shumard **does not maintain contact** with the wedge pocket 34 **throughout increasing mechanical or internal pressure loading of the pipe**. As the mechanical load increases, the wedge 40 ***pivots about the tooth 54 (if it contacts the pipe surface first-see Shumard col. 6, lines 43-49) or about tooth 52 (if it contacts the pipe surface first-see Shumard col. 7, lines 29-30) due to the threaded bolt 32 being in contact with the wedge groove 48***. As any pull-out load is applied to the pipe, the wedge 40 pivots about tooth 52, neither the front surface 46[5], nor any other wedge surface **maintains contact** with any wedge pocket 34 surface, including surface 28. Specifically, as any pull-out load is applied to the pipe, the wedge 40 immediately loses contact with the wedge pocket surface 28. Thus, Shumard clearly fails to teach a segment that:

> …which maintains contact with said surface of said cavity throughout increasing mechanical or internal pressure loading applied to the pipe, for driving

prevents further motion. Shumard, col. 7, lines 31-35.

[5] Fig. 5 of Shumard shows the front wedge surface 46 in contact with the front wall 28 of the wedge housing 18. But that depicts the state of the wedge 40 at the beginning of the loading sequence which is shown in Figs. 5-7 of Shumard (Shumard, col. 7, lines 9-10). Once pipe pressurization occurs (Shumard, col. 4, lines 34-35) i.e., as soon as any significant loading occurs, the wedge 40 loses contact with all wedge housing surfaces (see Figs. 6-7).

> said second portion deeper into the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, said segment resisting pipe pull-out in proportion to the increased mechanical or internal pressure loading applied to the pipe.

The Examiner simply repeats the language of Claim 1 and asserts that Shumard teaches these specified limitations ***but provides no support for such assertions***. Thus, for all of these reasons, Appellant respectfully submits that Claim 1 is patentable over Shumard.

Claim 2

The Examiner finally rejected Claim 2 as follows:

> In regards to claim 2, Shumard et al disclose a threaded bolt (32) extending through each of the threaded bores, the threaded bolt displaces the segment so that the second portion initially engages the outer surface of the pipe, and wherein the segment pivots about the first portion while losing contact with the threaded bolt. (Final Rejection, p. 3).

The Examiner fails to identify anywhere in Shumard where the wedge 40 loses contact with the threaded bolt 32. In total contrast to Shumard, the joint restraint assembly of the present invention utilizes a segment-cavity configuration whereby a threaded bolt displaces the segment so that the second portion initially contacts the outer surface of the pipe. As the mechanical and/or pressure loading increases, these forces are transmitted to the segment which, in turn, transmits these forces to a corner of the cavity, thereby creating a resistance in proportion to these loading forces, while *losing contact with the bolt*. This can be seen clearly in Fig. 5 where the threaded bolt 7 no longer is in contact with the segment 6 which is providing the resistance in proportion to the mechanical and/or internal pressure loading. In particular,

> With this segment configuration, the function of the threaded bolt is reduced to pre-loading the segment against the pipe surface, at the time of assembly, sufficiently to resist handling loads and low levels of internal pipe pressure. Upon application of sufficient mechanical and/or internal pressure loading, a corner of the segment is caused to firmly contact an interior corner of the cavity, and the continued application of mechanical and/or internal pressure loading causes additional rotation of the segment between the interior corner of the cavity and the pipe surface. In doing so, the segment performs in a

> self-actuating manner where the force tending to cause the segment edge to penetrate deeper into the pipe surface is proportional to the increase in mechanical and/or internal pressure loading. Accordingly, the entire length of the segment edge is caused to penetrate deeper into the pipe surface as required to resist the applied loading, well beyond the penetration achievable from the force applied by the threaded bolt alone or any prior art arrangement. <u>The threaded bolt does not contribute to securing the joint restraint assembly onto the pipe during higher levels of loading</u> (emphasis added, Present Application, p. 10, lines 3-22).

and

> Pipe pull-out load 17 is applied longitudinally to segment 6 through force vector component 20. The direction of force vector 19 is defined by the geometry between the penetrating segment edge 16 and pivot corner 12, and the magnitude of force vector 19 is dependent upon this angle and the magnitude of vector component 20. The radial component 21 of force vector 19 is similarly dependent on the geometric angle of force vector 19 and its magnitude. Accordingly, radial vector component 21 is also dependent on the magnitude of vector component 20 and, in turn, pull-out load 17. The radial vector component 21 causes the segment edge 16 to penetrate pipe surface 15. As a result, after overcoming the comparatively small pre-load provided by threaded bolt 7, the depth of penetration of segment edge 16 into pipe surface 15, and thus the ability to resist pipe pull-out load 17, is directly proportional to the mechanical and/or internal pressure loading applied to the pipe – i.e., the mechanism is "self-actuating." <u>Under these conditions, the threaded bolt 7 no longer contributes to the ability of the joint restraint assembly to resist the pull-out load 17, and threaded bolt 7 is not subjected to pull-out load 17 or damage therefrom; note in Fig. 5 that the rounded end of the threaded bolt 7 is no longer in contact with the segment 6. Thus, the self-actuating feature of the segment 6 operates independently of the threaded bolt 7</u>. (emphasis added, Present Application, p. 13, line 17 to page 14, line 4).

In contrast, as mentioned earlier, the Shumard joint restraint device 10 also utilizes a threaded bolt 32 (or 86), but unlike the present invention, this bolt 32 is in contact with the wedge 40 and, in fact, *<u>ends up carrying the loading forces</u>*. See Figs. 3-7 of Shumard where the bolt end 50 maintains contact with the wedge 40 **<u>throughout the loading process</u>**. In contrast, in the present invention, as mentioned earlier, the threaded bolt 7 is used to pre-load the segment 6 against the pipe; the bolt 7 is <u>not</u> relied upon to cause the segment edge 16 to bite into the pipe but rather the mechanical and/or internal pressure loading causes the segment edge 16 to bite into the pipe. In contrast, the bolt 32 (or 86) of Shumard is rotated or torqued to drive the tooth 52

into the pipe surface 56[6]. Thus, the bolt 32 (or 86) of Shumard is used to embed the first tooth 52 into the pipe surface; thereafter all of the forces from the wedge 40, applied through the teeth 52/54 are transmitted through the wedge 40 to the bolt 32 (or 86), resulting in bending the bolt. Therefore, for all of these reasons, Appellant submits that the threaded bolt 32 of Shumard remains in contact with the wedge groove 48 as the wedge 40 pivots about the tooth 52 or 54, ***thereby maintaining contact with the wedge 40, and not losing contact***. Furthermore, as mentioned earlier, the wedge 40 of Shumard has no first portion, as specified in Claim 1, that pivots against any surface of the wedge pocket 34 as pull-out load on the pipe increases. As such, Shumard does not teach any of the specified features of Claim 2, namely, a segment that pivots about said first portion while losing contact with the threaded bolt.

Claim 3

The Examiner finally rejected Claim 3 as follows:

> In regards to claim 3, Shumard et al disclose the segment transmitting the load from the pipe to the body while loading the segment primarily in compression. (Final Rejection, p. 3).

The Examiner supplemented these assertions with the following:

> Applicant argues Shumard et al do not disclose the segment transmitting the load from the pipe to the body while loading the segment primarily in compression. The Examiner disagrees. In Figure 5, Shumard et al clearly illustrate the segment transmitting the load from the pipe to the body while loading the segment primarily in compression. (Final Rejection, p. 7).

Once the teeth 52/54 of Shumard are embedded into the pipe surface, to resist pipe pull-out loads, the teeth 52/54 of the wedge 40 are loaded almost in pure shear, *not compression*. Although the Shumard bolt 32 contact with the wedge groove 48 provides compressive stress at that contact, the bulk of the wedge 40 is in shear from loads applied at the teeth 52/54 and

[6] Shumard, col. 6, lines 30-37.

transferred to the bolt 32 from the stop 78. In order for the pipe to slip out of the Shumard joint assembly 10, all that is required is that the teeth 52/54 shear off the wedge 40. In contrast, in the present invention, the segment edge 16 and bulk of the segment 6 is loaded primarily in compression **as indicated by the load path in Fig. 5 of the present application**, force vectors 19 and 22. Force vector 19 has two components, 20 and 21 that act at the same time, so force vector 20 cannot exist without force vector 21 and vice versa; thus, the net result is force vector 19, and that is not in a direction that would shear off the segment edge 16. The Examiner asserts that Fig. 5 of Shumard clearly shows the wedge 40 is primarily loaded in compression but one skilled in the art would conclude that Fig. 5 clearly shows that the wedge 40 is loaded primarily in shear. Thus, Appellant submits that Shumard does not teach a segment that is loaded primarily in compression and respectfully submits that Claim 3 is patentable.

Claim 4

The Examiner finally rejected Claim 4 as follows:

> In regards to claim 4, Shumard et al disclose the second portion comprising at least one edge (52, 54) which penetrates the external surface of the pipe. (Final Rejection, p. 3).

The Examiner supplemented these assertions with the following:

> Further, Applicant's and Shumard et al's Figure 5 both illustrate the same claim limitation regarding penetration. (Final Rejection, p. 8).

Claim 4 is dependent upon Claim 3 and is patentable for the same reasons. As such, Appellant respectfully request that the §102(b) rejection be withdrawn against Claim 4[7].

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[7] It should be noted that with respect to the second tooth 54, Shumard actually includes a means for ***preventing*** penetration of the second tooth 54 into pipe surface due to over-torquing:

> In a preferred embodiment of the present invention, the bottom surface 42 of the wedge 40 is tapered between the first tooth 52 and the rear surface 74 of the wedge 40 in order to form a bearing 76 that dissipates the actuation load of the bolt 32 on the wedge 40 over a relatively large area. After the first tooth 52 is fully embedded in the pipe surface 56,

Claim 5

The Examiner finally rejected Claim 5 as follows:

> In regards to claim 5, Shumard et al disclose the at least one edge forming a relief angle, as measured from the outer surface of the pipe, that is 25 to 35 degrees (implied). (Final Rejection, p. 3).

Claim 5 is dependent upon Claim 4 and is patentable for the same reasons. Furthermore, the relief angle range of 25 to 35 degrees provides the segment edge 16 with a sharp enough edge to penetrate the pipe surface but at the same time provides the segment edge 16 with sufficient strength to withstand the compression that the segment 6 is experiencing, specified in Claim 3. In contrast, because the teeth 52/54 of the wedge 40 of Shumard are loaded primarily in shear by pipe pull-out loads, there is no compression factor that the Shumard teeth 52/54 need to withstand and thus the relief angle is not limited to the specified range. Shumard does not teach or even suggest such a relief angle range and Appellant requests how the Examiner concludes that such a relief angle range is "implied" in Shumard. As such, Appellant respectfully requests that the §102(b) rejection be withdrawn against Claim 5.

Claim 6

The Examiner finally rejected Claim 6 as follows:

> In regards to claim 6, Shumard et al disclose the circumferential length of all of the segments and their edges comprising a substantial portion of the pipe periphery. (Final Rejection, p. 3).

Claim 6 is dependent upon Claim 3 and is patentable for the same reasons. Furthermore, Shumard transfers the force from the wedge 40, through the bolt 32 (or 86), to the body 14 so that the forces from the wedges 40 are imparted to the body 14 at ***discrete locations of the bolts***

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the bearing 76 is seated against the pipe surface 56 such that over-torquing does not result in penetration of the second tooth 54 into the pipe surface 56. (emphasis added, Shumard, col. 6, lines 50-58).

32. In contrast, the present invention has the force being transmitted from the corner 12 of the segment 6 into the interior corner 13 of the cavity 4 ***over a distance almost as long as the segment 6 is long***[8]. There is no contact in the center of the segment 6 where the bolt 7 is located. In the Shumard device, the wedge action and the radial force generated therefrom are limited by the stop 78 bearing against the bolt 32 (Shumard, Fig. 7). In contrast, the self-actuating mechanism of the present invention does not limit the radial force, and the edges 16 of the segments 6 comprise a substantially larger portion of the pipe periphery than can be successfully embedded into the pipe surface by the Shumard wedge action. The result is the distribution of the force transmitted through contact with the pipe more uniformly around the pipe periphery and distributing the force transmitted through contact with the body more uniformly around the body, independently of the bolt. However, in Shumard, as stated previously, the Shumard device *uses* the bolt 32 to carry the mechanical or internal pressure loading. As also mentioned previously with respect to Shumard, when the pipe pull out loading is the maximum, (and as shown in Fig. 7 of Shumard), the end of the bolt is pressed against the front edge (stop) 78, resulting in the bolt 32 taking all of the loading (and possibly bending). Once again, the Examiner simply repeats the language of Claim 6 and asserts that Shumard teaches these specified limitations ***but provides no support for such assertions***. As such, Appellant respectfully requests that the §102(b) rejection be withdrawn against Claim 6.

Claim 7

The Examiner finally rejected Claim 7 as follows:

> In regards to claim 7, Shumard et al disclose the shape of the body being optimized to resist the forces imparted to it by contact with the segments, the body

[8] Accordingly, the entire length of the segment edge is caused to penetrate deeper into the pipe surface as required to resist the applied loading, well beyond the penetration achievable from the force applied by the threaded bolt alone or any prior art arrangement. (Present application, p. 10, lines 16-22).

> comprising: a substantially cylindrical portion adjacent to the pipe surface with flange extending radially therefrom; and wherein the body comprising a shape and wall thickness that compensates for the presence of the cavities for maintaining the strength and rigidity of the body. (Final Rejection, p. 3).

Claim 7 is dependent upon Claim 1 and is patentable for the same reasons. Furthermore, in the Shumard device the body 14 is not, as specified by Claim 7, *optimized to resist the forces imparted to it by contact with the segments* because the wedge 40 does not contact the body 14, or impart any force to the body 14 except through bolt 32, as discussed previously. In particular, because of the "self-actuating" operation of the segment 6 of the present invention, the radial forces imparted to the body 2 from segment 6 are not present in the Shumard device. As depicted in the vector diagram of Fig. 5 of the present application, the radial load (vector component 21) is imparted to the body 2 via the segment 6 as force vector 24 and is proportional to the axial load (vector components 20 and 23). Thus, as the axial loads increase, the segment 6 conveys a corresponding increase in radial load to the body 2; as a result, the body 2 is carrying a correspondingly large radial load in addition to the axial load through the segment 6, and therefore the body 2 design must be able to resist these forces. In contrast to this, in Shumard, as the axial load increases, the radial load produced by the wedge action is limited by the wedge stop 78. None of the walls of the Shumard wedge pocket 34 are receiving the substantial (and increasing) radial loads that body 2 of the present invention is receiving. Therefore, the annular body 14 of Shumard is **not** "optimized to resist the forces imparted to it by contact with the segments" since there is no load transferred by contact of the wedge 40 with the body 14, and Shumard body 14, with its open rear face 38 (Shumard, col. 5, line 13), does **not** comprise "a shape and wall thickness to compensate for the presence of said cavities to maintain the strength and rigidity of said body." As such, Appellant respectfully requests that the §102(b) rejection be

withdrawn against Claim 7.

<u>Claim 19</u>

The Examiner finally rejected Claim 19 as follows:

> In regards to claims 19 and 20, Shumard et al disclose the first portion comprising a corner opposite the at least one edge, the corner contacting the surface of the cavity. (Final Rejection, p. 5).

Claim 19 is dependent upon Claim 1 and is patentable for the same reasons. Furthermore, as discussed previously, Fig. 5 of Shumard shows the front wedge surface 46 in contact with the front wall 28 of the wedge housing 18. But that depicts the state of the wedge 40 at the beginning of the loading sequence which is shown in Figs. 5-7 of Shumard (Shumard, col. 7, lines 9-10). Once pipe pressurization occurs (Shumard, col.4, lines 34-35), i.e., as soon as any significant loading occurs, the wedge 40 loses contact with all wedge housing surfaces (see Figs. 6-7). Thus, not only does Shumard not disclose a first portion of the wedge 40 that maintains contact throughout increasing mechanical/internal pressure loading, but Shumard does not disclose a wedge ***<u>corner</u>*** that maintains such contact.

1(b). THE EXAMINER ERRED IN CONCLUDING THAT SHUMARD SHOWS ALL THE ELEMENTS OF CLAIMS 9-14 AND 20

In the Final Rejection dated January 27, 2006, the Examiner finally rejected Claims 9-14 under 35 U.S.C. §102(b) asserting Shumard provides all the elements of Claim 9. Appellant submits that the Examiner has failed to show how Shumard anticipates the present invention as discussed below for the indicated claims.

Claim 9

The Examiner finally rejected Claim 9 as follows:

> In regards to claim 9, Shumard et al disclose a joint restraint assembly (10) comprising:
>
> a body (14) encircling the pipe, with the body having a plurality of cavities (34) adjacent the pipe and at least one set of a corresponding plurality of threaded bores (20) disposed through the body, each threaded bore of the at least one set of a corresponding plurality of threaded bores being in communication with a respective cavity;
>
> a segment (40) disposed within each of the cavities in the body, the segment comprising a first portion (46) that contacts a surface (28) of the cavity and a cam surface (52) that engages and rotates against, but does not substantially penetrate, the outer surface of the pipe, the segment pivoting about the first portion, which maintains contact with the surface of the cavity throughout increasing mechanical or internal pressure loading applied to the pipe so that the cam surface rotates against the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, the segment resisting pipe pull-out to the increased mechanical or internal pressure loading applied to the pipe. (Final Rejection, p. 4).

The Examiner supplemented these assertions with the following:

> The Applicant argues that Shumard et al do not disclose a segment disposed within each of the cavities in the body, the segment comprising a first portion that contacts a surface of the cavity and a cam surface that engages and rotates against, but does not substantially penetrate, the outer surface of the pipe, the segment pivoting about the first portion, which maintains contact with the surface of the cavity throughout increasing mechanical or internal pressure loading applied to the pipe so that the cam surface rotates against the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, the segment resisting pipe pull-out to the increased mechanical or internal pressure loading applied to the pipe. The Examiner disagrees. In Figure 5, Shumard et al clearly illustrates a segment (40) disposed within each of the cavities in the body, the segment comprising a first portion (46) that contacts a surface (28) of the cavity and a cam surface (52) that engages and rotates against, but does not substantially penetrate, the outer surface of the pipe, the segment pivoting about the first portion, which maintains contact with the surface of the cavity throughout increasing mechanical or internal pressure loading applied to the pipe so that the cam surface rotates against the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, the segment resisting pipe pull-out to the increased mechanical or internal pressure loading applied to the pipe.
>
> Further, Applicant's and Shumard et al's Figure 5 both illustrate the same claim limitation regarding penetration. (Final Rejection, pp. 7-8).

Appellant asserts that nowhere does Shumard teach a cam surface for rotating against the outer surface of the pipe. In particular and similar to Claim 1, Claim 9 specifies that the first

portion (e.g., corner 12) of the segment 6A that contacts the cavity surface (e.g., interior cavity corner 13) **maintains that contact throughout increasing mechanical or internal pressure loading applied to the pipe**. This feature permits the cam surface (16A or 16B) to pivot about the first portion while rotating against, but without substantially penetrating[9], the outer surface of the pipe as the mechanical loading increases, thereby providing resistance to pipe pull-out in proportion to this increased mechanical or internal pressure loading. Claim 9 specifies that the cam surface **rotates against, but does not substantially penetrate, the outer surface of the pipe** throughout increasing mechanical or internal loading applied to the pipe. In contrast, as the pipe loading increases in Shumard, the second tooth 54 is driven into (penetrates) the pipe surface (Shumard, col. 7, line 28). Whereas the segment 16A or 16B structure of the present invention provides for resistance to pipe pull-out that is in proportion to the mechanical or internal pressure loading as the cam surface rotates against the outer surface of the pipe. Shumard does not teach nor suggest a cam surface as specified, and relies upon the penetration of teeth 52/54 into the pipe surface to resist pipe pull-out loads. As such, Appellant respectfully requests that the §102(b) rejection be withdrawn against Claim 9.

Claim 10

The Examiner finally rejected Claim 10:

> In regards to claims 10 and 13, Shumard et al disclose a threaded bolt (32) extending through each of the threaded bores, the threaded bolt displaces the segment so that the second portion initially engages the outer surface of the pipe, and wherein the segment pivots about the first portion while losing contact with the threaded bolt. (Final Rejection, p. 4).

[9] The phrase "substantially penetrate" is meant to distinguish between the cam surface of the present invention that rolls against the outer pipe surface with some impression due to the compression force whereas, in contrast, the teeth 52/54 of Shumard act as

Claim 10 adds the feature to Claim 9 of the joint restraint assembly segment-cavity configuration whereby a threaded bolt displaces the segment so that the cam surface initially engages the outer surface of the pipe. As the mechanical and/or pressure loading increases, these forces are transmitted to the segment, 16A or 16B which, in turn, transmits these forces to a corner of the cavity, thereby creating a resistance in proportion to these loading forces *and while the segment loses contact with the threaded bolt*. As discussed earlier, Shumard discloses a joint restraint assembly that operates *where the bolts 32 (or 86) are used for carrying the loads*. Furthermore, as mentioned earlier, the wedge 40 of Shumard has no first portion, as specified in Claim 9, that pivots against any surface of the wedge pocket 34 in association with the application of mechanical or pressure loading on the pipe. As such, Shumard does not teach any of the specified features of Claim 10, namely, a segment that pivots about said first portion while losing contact with the threaded bolt. As such, Appellant respectfully requests that the §102(b) rejection be withdrawn against Claim 10.

Claim 11

The Examiner finally rejected Claim 11 as follows:

> In regards to claim 11, Shumard et al disclose the segment transmitting the load from the pipe to the body while loading the segment primarily in compression. (Final Rejection, p. 4).

Claim 11 adds the feature to Claim 9 of the segment transmitting the load from the pipe to the body while loading the segment primarily in compression. As discussed earlier, Shumard discloses a joint restraint assembly whose wedge 40, and particularly teeth 52/54, operates primarily in shear. As such, Appellant respectfully requests that the §102(b) rejection be withdrawn against Claim 11.

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knife edges to cut into and *substantially penetrate* the pipe surface.

Claim 12

The Examiner finally rejected Claim 12 as follows:

> In regards to claim 12, Shumard et al disclose a cam surface further comprising a surface texture for engaging the pipe surface. (Final Rejection, p. 5).

Claim 12 is dependent upon Claim 9 and is patentable for the same reasons. Furthermore, since Shumard does not teach or suggest a cam surface but rather only teeth 52/54 which act like a knife edge to penetrate the pipe surface, there would be no incentive to include a surface texture 16B (e.g., knurled surface-see present application, p. 15, lines 24 and Fig. 7a) on the teeth 52/54 of Shumard; if anything, it is desirable to keep the teeth 52/54 very smooth, rather than textured, to easily cut into the pipe surface. As such, Appellant respectfully requests that the §102(b) rejection be withdrawn against Claim 12.

Claim 13

The Examiner finally rejected Claim 13 as follows:

> In regards to claims 10 and 13, Shumard et al disclose a threaded bolt (32) extending through each of the threaded bores, the threaded bolt displaces the segment so that the second portion initially engages the outer surface of the pipe, and wherein the segment pivots about the first portion while losing contact with the threaded bolt. (Final Rejection, p. 4).

Claim 13 adds the feature to Claim 12 of the joint restraint assembly segment-cavity configuration whereby a threaded bolt displaces the segment so that the cam surface initially engages the outer surface of the pipe. As the mechanical and/or pressure loading increases, these forces are transmitted to the segment, 16A or 16B which, in turn, transmits these forces to a corner of the cavity, thereby creating a resistance in proportion to these loading forces *and while the segment loses contact with the threaded bolt*. As discussed earlier, Shumard discloses a joint restraint assembly that operates *where the bolts 32 (or 86) are used for carrying the loads*.

Furthermore, as mentioned earlier, the wedge 40 of Shumard has no first portion, as specified in Claim 9, that pivots against any surface of the wedge pocket 34 in association with the application of mechanical or pressure loading on the pipe. As such, Shumard does not teach any of the specified features of Claim 13, namely, a segment that pivots about said first portion while losing contact with the threaded bolt. As such, Appellant respectfully requests that the §102(b) rejection be withdrawn against Claim 13.

Claim 14

The Examiner finally rejected Claim 14 as follows:

> In regards to claim 14, Shumard et al disclose the segment transmitting the load from the pipe to the body while loading the segment primarily in compression.

Claim 14 is dependent upon Claim 12 and is patentable for the same reasons. Furthermore, Claim 14 adds the feature to Claim 12 of the segment transmitting the load from the pipe to the body while loading the segment primarily in compression, as depicted by the load vectors shown in Fig. 5 of the present application. As discussed earlier, Shumard discloses a joint restraint assembly whose wedge 40, and particularly teeth 52/54, operates primarily in shear, as it transmits pipe-pull out loads from teeth 52/54 to bolt 32 (or 86). As such, Applicants respectfully request that the §102(b) rejection be withdrawn against Claim 14.

Claim 20

The Examiner finally rejected Claim 20 as follows:

> In regards to claims 19 and 20, Shumard et al disclose the first portion comprising a corner opposite the at least one edge, the corner contacting the surface of the cavity.

Claim 20 is dependent upon Claim 9 and is patentable for the same reasons. Furthermore, as discussed previously, Fig. 5 of Shumard shows the front wedge surface 46 in contact with the front wall 28 of the wedge housing 18. But that depicts the state of the wedge 40 at the beginning of the loading sequence which is shown in Figs. 5-7 of Shumard (Shumard, col. 7, lines 9-10). Once pipe pressurization occurs (Shumard, col.4, lines 34-35), i.e., as soon as any significant loading occurs, the wedge 40 loses contact with all wedge housing surfaces (see Figs. 6-7). Thus, not only does Shumard not disclose a first portion of the wedge 40 that maintains contact throughout increasing mechanical/internal pressure loading, but Shumard does not disclose a wedge ***corner*** that maintains such contact.

2. THE EXAMINER ERRED IN CONCLUDING THAT CLAIM 8 IS UNPATENTABLE UNDER 35 U.S.C. §103(a) OVER SHUMARD IN VIEW OF PANNELL

In the Final Rejection dated January 27, 2006, the Examiner has finally rejected Claim 8 under 35 U.S.C. §103(a) as being unpatentable over Shumard in view of U.S. Patent No. 4,848,808 (Pannell, et al. hereinafter "Pannell"; see "Evidence Appendix"). In particular, the Examiner asserts that:

> In regards to claim 8, Shumard et al discloses the claimed invention except for an elastomeric material positioned between each of the segments and their corresponding cavities, the elastomeric material disposing the segment in the cavity in an optimum position. Pannell et al teach an elastomeric material (170) positioned between each of the segments (210) and their corresponding cavities, the elastomeric material disposing the segment in the cavity in an optimum position, to graduate the effecting force of the sudden application of a sliding force (col. 4, lines 25-40). As Pannell et al relate to mechanical pipe joints utilizing pipe clamping systems, it would have been obvious to one having ordinary skill in the art at the time the invention was made to provide an elastomeric material positioned between each of the segments and their corresponding cavities, the elastomeric material disposing the segment in the cavity in an optimum position, to graduate the effecting force of the sudden application of a sliding force, as taught by Pannell et al.

Appellant respectfully disagrees for the following reasons.

Claim 8 is dependent upon Claim 1 and is patentable for the same reasons. Furthermore, Pannell discloses a mechanical pipe joint whereby a compressible gasket 170 protects a pipe restraining member 40 from sudden shock by tending to graduate any application of force to a second block 120 resulting from sudden forces acting in pipes 10/10A[10]. However, in contrast, in the present invention, the elastomeric material 29 (see Fig. 3 of present application, and p. 12, lines 30-32; see also page 11, lines 20-29) does *not* absorb any force or graduate any force. Rather, as specified in Claim 8, the elastomeric material 29 disposes the segment "in said cavity in an optimum position for self-actuation or for retaining said segment in said cavity for shipping, handling and installation." Furthermore, Shumard already contains a shroud 60 that holds the respective wedges 40 in their respective wedge housings prior to installation[11]. Thus, there would be no incentive to add the compressible gasket 170 to pre-position the wedge 40 in the wedge pocket 34 if there already is a pre-positioning shroud 60 used by Shumard. As such, Applicants respectfully request that the §102(b) rejection be withdrawn against Claim 8.

[10] Pannell, col. 4, lines 25-40.
[11] Shumard, col. 5, lines 43-50.

CONCLUSION

In view of the above remarks, Appellant submits that the rejection of Claims 1-14, 19 and 20 is improper and should be reversed and such action is respectfully requested.

Respectfully submitted,

CAESAR, RIVISE, BERNSTEIN,
COHEN & POKOTILOW, LTD.

April 20, 2006

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Please charge or credit our Account No. 03-0075 as necessary to effect entry and/or ensure consideration of this submission.

CLAIMS APPENDIX

1. A joint restraint assembly for connecting pipe ends together, or to other objects, by gripping the outer surface of the pipe, the joint restraint assembly comprising:

a body encircling the pipe, with said body having a plurality of cavities adjacent the pipe and at least one set of a corresponding plurality of threaded bores disposed through said body, each threaded bore of said at least one set of a corresponding plurality of threaded bores being in communication with a respective cavity; and

a segment disposed within each of said cavities in said body, said segment comprising a first portion that contacts a surface of said cavity and a second portion that penetrates the outer surface of the pipe, said segment pivoting about said first portion, which maintains contact with said surface of said cavity throughout increasing mechanical or internal pressure loading applied to the pipe, for driving said second portion deeper into the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, said segment resisting pipe pull-out in proportion to the increased mechanical or internal pressure loading applied to the pipe.

2. The joint restraint assembly of Claim 1 further comprising a threaded bolt extending through each of said threaded bores, said threaded bolt displacing said segment so that said second portion initially engages said outer surface of the pipe, and wherein said segment pivots about said first portion while losing contact with said threaded bolt.

3. The joint restraint assembly of Claim 1 wherein said segment transmits the load from the pipe to said body while loading said segment primarily in compression.

4. The joint restraint assembly of Claim 3 wherein said second portion comprises at least one edge which penetrates the outer surface of the pipe.

5. The joint restraint assembly of Claim 4 wherein said at least one edge forms a relief angle, as measured from the outer surface of the pipe, that is 25 to 35 degrees.

6. The joint restraint assembly of Claim 3 wherein the circumferential length of all of said segments and their edges comprises a substantial portion of the pipe periphery.

7. The joint restraint assembly of Claim 1 wherein the shape of the body is optimized to resist the forces imparted to it by contact with said segments, said body comprising:

a substantially cylindrical portion adjacent to the pipe surface with a flange extending radially therefrom; and

wherein said body comprises a shape and wall thickness that compensates for the presence of said cavities for maintaining the strength and rigidity of said body.

8. The joint restraint assembly of Claim 1 further comprising an elastomeric material positioned between each of said segments and their corresponding cavities, said elastomeric material disposing said segment in said cavity in an optimum position for self-actuation or for retaining said segment in said cavity for shipping, handling and installation.

9. A joint restraint assembly for connecting pipe ends together, or to other objects, by gripping the outer surface of the pipe, the joint restraint assembly comprising:

a body encircling the pipe, with said body having a plurality of cavities adjacent the pipe and at least one set of a corresponding plurality of threaded bores disposed through said body, each threaded bore of said at least one set of a corresponding plurality of threaded bores being in communication with a

respective cavity;

a segment disposed within each of said cavities in said body, said segment comprising a first portion that contacts a surface of said cavity and a cam surface that engages and rotates against, but does not substantially penetrate, the outer surface of the pipe, said segment pivoting about said first portion, which maintains contact with said surface of said cavity throughout increasing mechanical or internal pressure loading applied to the pipe so that said cam surface rotates against the outer surface of the pipe in proportion to the applied mechanical or internal pressure loading, said segment resisting pipe pull-out in proportion to the increased mechanical loading or internal pipe pressure.

10. The joint restraint assembly of Claim 9 further comprising a threaded bolt extending through each of said threaded bores, said threaded bolt displacing said segment so that said cam surface initially engages said outer surface of the pipe, and wherein said segment pivots about said first portion while losing contact with said threaded bolt.

11. The joint restraint assembly of Claim 9 wherein said segment transmits the load from the pipe to said body while loading said segment primarily in compression.

12. The joint restraint assembly of Claim 9 wherein said cam surface further comprises a surface texture for engaging the pipe surface.

13. The joint restraint assembly of Claim 12 further comprising a threaded bolt extending through each of said threaded bores, said threaded bolt displacing said segment so that said cam surface initially engages said outer surface of the pipe, and wherein said segment pivots about said first portion while losing contact with said threaded bolt.

14. The joint restraint assembly of Claim 12 wherein said segment-transmits the load from the pipe to said body while loading said segment primarily in compression.

19. The joint restraint assembly of Claim 4 wherein said first portion comprises a corner opposite said at least one edge, said corner contacting said surface of said cavity.

20. The joint restraint assembly of Claim 9 wherein said first portion comprises a corner opposite said cam surface, said corner contacting said surface of said cavity.

EVIDENCE APPENDIX

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
APPLICATION FOR LETTERS PATENT

APPLICANTS : Charles J. Longacre and David F. Toler

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1257 Firethorne Drive Easton, PA 18045-7421, respectively,

INVENTION : JOINT RESTRAINT ASSEMBLY

ATTORNEYS : Caesar, Rivise, Bernstein, Cohen & Pokotilow, Ltd.
12th Floor, Seven Penn Center
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TO ALL WHOM IT MAY CONCERN:

Be it known that we, the above-identified applicants, have made a certain new and useful invention in a JOINT RESTRAINT ASSEMBLY of which the following is a specification.

PRESENT APPLICATION

TITLE OF THE INVENTION:

JOINT RESTRAINT ASSEMBLY

SPECIFICATION

BACKGROUND OF THE INVENTION

1. FIELD OF INVENTION

The present invention relates to a joint restraint assembly. More particularly, the present invention relates to a joint restraint assembly for connecting pipes together, or to other objects.

2. DESCRIPTION OF RELATED ART

Joint restraint assemblies of several types are known in the art and which comply with pipe connection standards, such as the ANSI/AWWA C111/A21.11, entitled "American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings." A conventional restraint assembly comprises an annular body having a plurality of threaded bolts equally spaced around the body, with the threaded bolts extending through threaded bores disposed through the body along radial lines, or radial lines inclined at an angle of less than 90 degrees from the pipe axis. The end of each bolt is configured to directly bear on the pipe surface or another component that, in turn, bears on the pipe surface. The head of each bolt typically includes a torque head with a feature that is designed to shear when a predefined torque is applied to the bolt. The shear feature is intended to result in the application of a specific torque to each bolt without the use of a torque measuring wrench.

Once the joint restraint assembly is positioned adjacent the end of a pipe, the pipe end is mated into the socket and then the flange portion of the joint restraint is secured to a corresponding flange portion on the socket side via flange-connecting fasteners (e.g., "T-bolts"). See, for example, U.S. Patent Nos. 3,333,872 (Crawford, Sr. et al.); 3,726,549 (Bradley, Jr.); 4,848,808 (Pannell et al.) and 4,779,900 (Shumard). It should be understood that subsequent reference to "bolt" hereinafter refers to the bolts used to secure the joint

restraint assembly to the pipe end and not to the flange-connecting fasteners used to secure the flanges together unless indicated.

In some conventional restraint assemblies, the end of each bolt is either configured to penetrate the surface of the pipe or to bear upon a pad, clamping block, or segment with one or more gripping teeth to penetrate the surface of the pipe. In conventional restraint assemblies that utilize segments with one or more gripping teeth to penetrate hard pipe materials, such as ductile iron, the length of the gripping teeth penetrating the pipe surface and the depth of the penetration are limited by the force produced as a result of applying the specified torque to the threaded bolt. As a result, a conventional restraint assembly applies loading that is localized at the positions of the threaded bolts or clamping blocks. The allowable mechanical or pressure loading, tending to pull the pipe out of the restraint assembly, is limited by the shear strength of the pipe material and the area of the pipe material that would have to shear in order to permit the penetrating gripping teeth to slip along the pipe surface, with that shear area being related to the penetration depth of the gripping teeth into the pipe material and the circumferential length of the penetration. The allowable mechanical or pressure loading, tending to pull the pipe out of the restraint assembly, is also limited by the shear strength of the segment material and the area of the segment gripping teeth that would have to shear in order to separate the gripping teeth from the segment, with that shear area being related to the penetration depth of the gripping teeth into the pipe material and the circumferential length of the penetration. Accordingly, conventional restraint assemblies are often inadequate for comparatively high levels of mechanical loading and/or pipe internal pressure. See, for example, U.S. Patent Nos.817,300 (David); 3,333,872 (Crawford, Sr. et al.); 3,726,549 (Bradley, Jr.); 4,397,485 (Wood); Des. 294,384 (Endo et al.);

One type of conventional restraint assembly in the prior art comprises an annular body having a plurality of cavities

adjacent to the pipe with a clamping block configured to fit into each cavity. See, for example, U.S. Patent Nos. 4,092,036 (Sato et al.); 4,779,900 (Shumard);4,896,903 (Shumard) and 5,071,175 (Kennedy, Jr.). A plurality of bolts equally spaced around the body, disposed through the body along radial lines inclined at an angle of less than 90 degrees from the pipe axis, that extend through non-threaded oval holes into the cavities. The inboard surface of each cavity is perpendicular to the axis of the oval hole such that it is inclined to the axis of the pipe. Each bolt is configured with an integral annular flange, or collar, that is slidably in contact with the inclined surface of the cavity, and the threaded shank of each bolt is engaged in a threaded hole in the corresponding clamping block. Each clamping block is configured with teeth to directly bear on the pipe surface. When the threaded bolt is turned, force is applied to the clamping block causing the teeth to dent the pipe surface. An equal and opposite force is applied to the contact between the integral annular flange of the bolt and the inclined surface of the cavity. These contact surfaces are not polished and lubricated, and they are usually covered with a protective coating. (See for example EBAA Iron Sales, Inc., Wedge Action Megalug™ Field Installed Joint Restraint; EBAA Iron Sales, Inc., Series 3000 Multi-Purpose Wedge Action Restraint; or EBAA Iron Sales, Inc., Series 2000PV Megalug™ Retainer Glands for PVC Pipe with Cast-Iron or I.P.S. Outside Diameters with M.J. Bells). The service environment ordinarily results in corrosion, sediment particulate and other conditions that do not permit a low coefficient of sliding friction between the integral annular flange of the bolt and the inclined surface of the cavity.

The concept of this "wedge" type of restraint assembly is that as the mechanical or pressure loading tends to pull the pipe out of the restraint assembly, the annular flange on the threaded bolt slides along the inclined surface of the cavity causing the clamping block teeth to dent the pipe surface more deeply, thereby resisting the tendency of the pipe to pull out of the restraint assembly. In practice, the frictional forces

that resist sliding between the annular flange on the bolt and the inclined surface of the cavity are proportional to the force being applied to dent the pipe and, in combination with the mis-alignment of the force vectors tending to cause the annular flange of the bolt to bind instead of slide, the theoretical effect is only partially realized. All of the "wedge" type prior art has this inherent characteristic which limits its effectiveness. One manufacturer of this type of joint restraint assembly explains in its publications that this type of restraint works without wedge movement to resist normal operating pressure in the pipe, but wedge movement responds "only as the external force is increased" from additional external conditions such as subsidence, waterhammer, traffic loads or small tremors (EBAA Iron Sales, Inc., Wedge Action Megalug™ Field Installed Joint Restraint). However, in the normal operation of this type of restraint assembly, the force generated by the bolt is applied to the clamping block causing its teeth to dent the pipe surface, and if the wedge effect is able to overcome its inherent sliding friction and binding characteristics, it does so, inefficiently, only under additional external loading conditions.

Another type of conventional restraint assembly in the prior art comprises an annular body with equally spaced cavities with a segment configured to fit into each cavity. A threaded bolt extends through a threaded bore into each cavity, and the force generated by the threaded bolt is applied to the segment to cause the edges of the segment to dent the pipe surface. The end of the threaded bolt is manufactured with a hemispherical form, and it fits into a dished socket in the segment. (See Sigma/Napco, SuperLug™, Pipe Restraints for Ductile Iron Pipe). The manufacturer's publications state that: the ball and socket allows lug deflection at any angle, thereby allowing the lugs to "rock", actually gripping the pipe more securely as pressure-induced load increases; and pressure-induced load causes the primary contact edge of the SuperLug™ teeth to "grab" the pipe surface, further increasing pressure-induced load restraint.

However, testing of this design in larger sizes, such as for 30 to 48 inch diameter pipes, revealed that the force of the radial threaded bolt, even in combination with the "rocking" or "cam action", was insufficient to adequately grip the pipe, and other undesirable effects occurred such as bending of the threaded bolt. A parametric analysis of the design revealed that the pressure-induced load, tending to pull the pipe out of the restraint assembly, overpowered the capability of the design as the pressure-induced load increased with the square of the pipe diameter. Using a restraint assembly for 48 inch pipe as an example, the total axial load is in excess of 1,000,000 pounds during the hydrostatic proof test at 500 psi pressure. This requires each of 32 segments, and the threaded bolt forcing it into the surface of the pipe, to resist almost 32,000 pounds of pressure-induced load. When tightened to the specified torque, the threaded bolt is capable of applying 7,500 pounds of force to the segment, causing its edges to dent the surface of the pipe, but the indentation was not of sufficient depth and circumferential length to resist the 32,000 pounds of pressure-induced load. With the known shear strength of the pipe material, the required shear area of the pipe material that would have to resist shearing in order to prevent the penetrating, gripping teeth from slipping along the pipe surface, requires both a greater depth of penetration into the pipe material and a greater circumferential length of that penetration.

It would be desirable for a restraint assembly to overcome the inherent problems and limitations in the prior art and reliably accommodate comparatively high levels of mechanical loading and/or pipe pressure, and to do so without relying upon the limited force produced by the application of the specified torque to the threaded bolts.

The entire disclosures of all of the references cited herein are incorporated by reference.

BRIEF SUMMARY OF THE INVENTION

A joint restraint assembly for connecting pipe ends together, or to other objects, by gripping the outer surface of the pipe. The joint restraint assembly comprises: a body encircling the pipe, with the body having a plurality of cavities adjacent the pipe and at least one set of a corresponding plurality of threaded bores disposed through the body, and wherein each threaded bore of the at least one set of a corresponding plurality of threaded bores is in communication with a respective cavity; a segment disposed within each of the cavities in the body, and configured to make contact between the body and the surface of the pipe so as to provide resistance to pipe pull-out in proportion to the mechanical and/or internal pressure loading applied to the pipe (e.g., a self-actuating member); and a threaded bolt extending through each of the threaded bores to pre-load the respective segment into initial contact with the pipe surface.

A method for providing a joint restraint assembly with resistance to pipe pull-out in proportion to the mechanical and/or internal pressure loading applied to a pipe. The method comprises the steps of: providing a body that encircles the pipe wherein the body has a plurality of cavities and at least one set of a corresponding plurality of threaded bores disposed through the body, with the cavities being disposed adjacent the pipe; disposing a segment within each of the cavities; pre-loading the segment against the pipe by rotating a corresponding bolt disposed in each threaded bore of the at least one set of a corresponding plurality of threaded bores; permitting the segment to move within the cavity, independently of the bolts, in response to pipe pull-out forces, and wherein the segment is self-actuating and orients itself so that the segment is in contact with the body and the pipe surface and generates a resistance to the pipe pull-out forces in proportion to the mechanical and/or internal pressure loading applied to the pipe.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

The invention will be described in conjunction with the following drawings in which like reference numerals designate like elements and wherein:

Fig. 1 is an elevation view, or end view opposite the gasket side, of a joint restraint assembly embodying the present invention;

Fig. 1a is an elevation view, similar to the view of Fig. 1, showing only the joint restraint assembly body;

Fig. 2 is an elevation section view of the joint restraint assembly body taken along section plane A-A of Fig. 1a;

Fig. 3 is a section view taken through the center of a threaded bore and segment, along section plane C-C of Fig.1, showing the segment in position for shipping and assembly onto a pipe;

Fig. 4 is a section view taken through the center of a threaded bore and segment, along section plane C-C of Fig. 1, showing the segment during pre-loading on the surface of a pipe;

Fig. 5 is a section view taken through the center of a threaded bore and segment, along a section plane, similar to section plane C-C of Fig. 1, showing the segment in contact with the surface of a pipe and an interior corner of the cavity, the force vectors on the segment in transmitting the mechanical and/or pipe internal pressure loading while in use, and the self-actuating effect of the configuration;

Fig. 6 is a section view taken through the connecting aperture in the flange portion of the body, along section plane B-B of Fig.1, showing the basic tee shape of the pipe restraint body;

Fig. 7 is a section view of a second embodiment of the segment of the present invention taken along a view line similar to section plane C-C of Fig. 1, showing the self-actuating operation; and

Fig. 7a is a section view of a third embodiment of the segment of the present invention taken along a view line similar

to section plane C-C of Fig. 1, showing the self-actuating operation.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a joint restraint assembly. More particularly, the present invention relates to a joint restraint assembly for connecting pipes together, or to other objects. Although the following description of the preferred embodiment is considered by the inventors to be the best mode of carrying out the invention, the claims presented below are not limited to the particular details of the described embodiment. Many variations of the particular details of the described embodiment may be apparent to those skilled in the art which would provide for construction of the joint restraint assembly incorporating the principles of the present invention as claimed.

The present invention provides a joint restraint assembly suitable for connecting pipe that is subjected to comparatively high levels of mechanical loading and/or pipe internal pressure. The assembly includes a body encircling the pipe, with said body having a plurality of cavities adjacent to the pipe. A segment is configured to fit into said cavity and one or more threaded bores are disposed through the body into each cavity. A threaded bolt extends through said threaded bore to engage the segment in that cavity. The threaded bolt has a head suitable for applying torque to the bolt and may include a feature to limit the maximum torque which can be applied. When the specified torque is applied to the bolt head at the time of assembly, the force developed by the bolt serves to pre-load the segment against the pipe. Mechanical and/or pressure loading, tending to pull the pipe out of the restraint assembly, causes relative movement between the pipe and the restraint assembly. This relative movement causes the segment to firmly contact the interior corner of the cavity, and the application of increasing load and the associated relative movement, causes the segment to rotate resulting in a proportional increase to the force engaging the segment to the pipe. This action of the segment is

herein referred to as self-actuating. It should also be understood that subsequent reference to "mechanical and/or pressure loading" hereinafter includes the relative movement between the pipe and the joint restraint assembly that occurs as a result of the application of the mechanical and/or pressure loading. It should be further understood that this relative movement is not to be confused with slippage of the restraint assembly along the surface of the pipe.

The segment is configured to contact the surface of the pipe. The segment may function in a manner similar to a cam, pawl, dog, or other self-actuating member, and it may possess a surface treatment (e.g., a knurled surface)intended to reduce the likelihood of slipping on the pipe surface. To minimize the likelihood of slipping on the pipe surface, the segment of the preferred embodiment is configured with one or more edges capable of penetrating the external surface of the pipe Each edge is circumferentially-contoured to approximately match the curvature of the pipe. The segment, and each edge thereon, is of sufficient circumferential length to distribute the applied loading over a substantial portion of the pipe periphery. The segment possesses a form wherein the application of mechanical loading or pipe internal pressure causes the corner of the segment to contact an interior corner of the cavity to serve as a pivot for the segment. As a result, the loading transmitted from the pipe through the edge of the segment is transmitted to the corner of the segment in contact with the interior corner of the cavity. Accordingly, the loading from the edge of the segment, through the segment, to the corner contact location produces a state of stress in the segment that is primarily compressive. Transmitting the loading in this manner minimizes the tendency of the segment material to fracture. The relief angle adjacent to each edge of the segment, as measured from the pipe surface, is optimized to maximize the load transmission capability from the segment edge into the segment body while permitting the segment edge to penetrate the pipe surface

sufficiently to prevent slippage of the joint restraint assembly relative to the pipe.

With this segment configuration, the function of the threaded bolt is reduced to pre-loading the segment against the pipe surface, at the time of assembly, sufficiently to resist handling loads and low levels of internal pipe pressure. Upon the application of sufficient mechanical and/or internal pressure loading, a corner of the segment is caused to firmly contact an interior corner of the cavity, and the continued application of mechanical and/or internal pressure loading causes additional rotation of the segment between the interior corner of the cavity and the pipe surface. In doing so, the segment performs in a self-actuating manner where the force tending to cause the segment edge to penetrate deeper into the pipe surface is proportional to the increase in mechanical and/or internal pressure loading. Accordingly, the entire length of the segment edge is caused to penetrate deeper into the pipe surface as required to resist the applied loading, well beyond the penetration achievable from the force applied by the threaded bolt alone or any prior art arrangement. The threaded bolt does not contribute to securing the joint restraint assembly onto the pipe during higher levels of loading.

The self-actuating function of the segment produces internal force vectors with, in part, force vector components parallel to the surface of the pipe that resist movement due to the mechanical and/or internal pressure loading on the pipe tending to pull the pipe out of the joint restraint assembly. The body of the joint restraint assembly includes a radial flange having multiple axial apertures, equally spaced around the body, through which the flange-connecting fasteners are installed to secure the joint restraint assembly to another restraint assembly or another object. The difference in the radial positions of the force vector component parallel to the surface of the pipe, applied to the interior corner of the cavity, and the axial restraint force of the flange-connecting

fasteners is small in comparison to conventional joint restraint assemblies.

The force vectors internal to the segment, produced by its self-actuating function, also have force vector components that are perpendicular to the pipe surface, and it is this vector component applied at the edge of the segment that forces the segment edge to penetrate the surface of the pipe. The corresponding force vector component perpendicular to the pipe surface, applied to the interior corner of the cavity, substantially adds to the loading applied radially to the joint restraint body. Accordingly, the configuration of the body is optimized to resist this additional loading and the tendency of the body to roll about an axis through its cross-sectional center of area. The optimum body cross-section is in the shape of a tee, with the top of the tee being adjacent to the surface of the pipe and the leg of the tee forming the radial bolt flange of the joint restraint assembly. This basic shape was modified as required to incorporate the cavities, threaded bores and seal features into the body.

Elastomeric material is installed between each end of the segment and the corresponding walls of the cavity in order to retain the segment in position for shipping, handling and installation. Elastomeric material is also installed between one face of the segment and its corresponding wall of the cavity in order to pre-position the segment against the opposite wall of the cavity. Accordingly, the segment is pre-positioned for appropriately making contact with the interior corner of the cavity and the pipe surface, as pre-loaded by the threaded bolt, so as to establish the self-actuating position of the segment.

The joint restraint assembly of the present invention can be configured to fit pipes of any size or material, and to join or attach to any other type of restraint, sealing assembly or other object. The joint restraint assembly can be made from any suitable material or combination of suitable materials. For example, the present invention can be made from ductile iron.

In particular, an elevation view, or end view opposite the gasket side, of a joint restraint assembly 1 embodying the present invention is shown in Fig. 1. Joint restraint assembly 1 comprises a substantially circular body 2, or gland, that is slipped over the end of a pipe (not shown), and a gasket (not shown) is then slipped over the end of the pipe. The body 2 (shown in Fig. 1a) comprises connecting apertures 3 disposed through body 2 generally parallel to the longitudinal axis of the pipe. Flange-connecting fasteners (not shown), typically T-bolts, extend through the connecting apertures 3 to connect the joint restraint assembly 1 to another pipe or fitting (not shown).

As shown in Fig. 2, the body 2 of the joint restraint assembly 1 also comprises a plurality of cavities 4 adjacent to the surface of the pipe (not shown). A threaded bore 5 extends radially through body 2 into each cavity 4. A segment 6 is positioned within each cavity 4 in body 2 as shown in Fig. 3. A threaded bolt 7 extends through threaded bore 5 in body 2 to contact segment 6. The threaded bolt 7 comprises a reduced section 8 between an outboard hex head 9 and an inboard hex head 10, such that as torque is applied to outboard hex head 9, reduced section 8 shears at a pre-determined torque, and inboard hex head 10 remains attached to threaded bolt 7 for subsequent withdrawal of same, if needed. The end 11 of threaded bolt 7 is rounded to localize the contact with segment 6.

As shown in Fig. 3, assembled for shipping/handling and installation and slipping over the end of a pipe, each segment 6 is contained substantially within cavity 4 in body 2, with one corner 12 of segment 6 positioned in a corresponding interior corner 13 of cavity 4. Elastomeric material 29 is positioned between the sides of segment 6 and the walls of cavity 4 to maintain the segment in an optimum position for self-actuation.

After joint restraint assembly 1 and a gasket (not shown) are properly positioned on the end of a pipe 14, all the threaded bolts 7 are sequentially and uniformly tightened to pre-load segments 6 against the pipe surface 15 as shown in Fig.

4. As each segment 6 is pre-loaded against pipe surface 15, the edge 16 of segment 6 makes a small indentation into the pipe surface 15. Pre-loading each segment 6 against the pipe surface 15 is complete when reduced section 8 of the respective threaded bolt 7 shears from the application of pre-determined torque to hex head 9.

The application of mechanical load to the pipe and/or pressure within the pipe produces pipe pull-out load 17 as indicated in Fig. 5, with resulting relative movement between the pipe and the restraint assembly, as described previously. The resisting load 18 is provided by the flange-connecting fasteners (not shown) extending through connecting apertures 3 in body 2. These opposing loads 17 & 18 cause corner 12 of segment 6 to load against interior corner 13 of cavity 4 to serve as a pivot, and edge 16 of segment 6 penetrates deeper into the pipe surface 15.

Pipe pull-out load 17 is applied longitudinally to segment 6 through force vector component 20. The direction of force vector 19 is defined by the geometry between the penetrating segment edge 16 and pivot corner 12, and the magnitude of force vector 19 is dependent upon this angle and the magnitude of vector component 20. The radial component 21 of force vector 19 is similarly dependent on the geometric angle of force vector 19 and its magnitude. Accordingly, radial vector component 21 is also dependent on the magnitude of vector component 20 and, in turn, pull-out load 17. The radial vector component 21 causes the segment edge 16 to penetrate pipe surface 15. As a result, after overcoming the comparatively small pre-load provided by threaded bolt 7, the depth of penetration of segment edge 16 into pipe surface 15, and thus the ability to resist pipe pull-out load 17, is directly proportional to the mechanical and/or internal pressure loading applied to the pipe - i.e., the mechanism is "self-actuating." Under these conditions, the threaded bolt 7 no longer contributes to the ability of the joint restraint assembly to resist the pull-out load 17, and threaded bolt 7 is not subjected to pull-out load 17 or damage

therefrom; note in Fig. 5 that the rounded end of the threaded bolt 7 is no longer in contact with the segment 6. Thus, the self-actuating feature of the segment 6 operates independently of the threaded bolt 7.

Force vector 19 is transmitted through segment edge 16 to segment pivot 12 as force vector 22, thereby loading the segment edge primarily in compression. Force vector 22 has a longitudinal vector component 23, equal to both the pull-out load 17 and vector component 20, that transmits the load from segment 6 to body 2 at the cavity interior corner 13. Force vector component 23 is resisted by longitudinal force vector 18 from the flange-connecting fasteners (not shown) extending through connecting apertures 3 in body 2.

Force vector 22 has a radial vector component 24 that is equal to radial vector component 21. Vector component 24 is resisted by circumferential (hoop) stress induced within circular body 2. The distance between vector component 24 and the centroid 25 of the cross-section of body 2 tends to cause rolling of body 2 about its own centroidal axis. The distance between vector component 23 and resisting force vector 18 also tends to cause body 2 to roll in the same way. Accordingly, body 2 is shaped as shown in Fig. 6 to resist these circumferential and "rolling" stresses. The shape for body 2 found to be near optimum in resisting vector components 23 and 24 comprises a cylindrical portion 26 adjacent to the pipe surface 15 and a radial flange 27, perpendicular to the cylindrical portion, to serve as the flange for the flange-connecting fasteners (not shown). Thus, the basic cross-section of body 2 found to be near optimum was that of a Tee, with connecting apertures 3 disposed through the radial flange portion of body 2. Of course, this basic shape was altered in the vicinity of each cavity 4 as necessary to accommodate a segment 6 and threaded bore 5 as shown in Fig. 2 and Fig. 3.

The ability of segment edge 16 to penetrate pipe surface 15 is dependent on relief angle 28 as illustrated in Fig. 3. The maximum relief angle 28 is determined by the shape of segment 6

that produces a load path through segment edge 16 that is primarily compressive, to avoid loading the edge in shear. The optimum relief angle 28 is in the range of 25° to 35°.

It should be understood that the circumferential length of the plurality of segments 6 and their edges 16 comprises a substantial portion of the pipe periphery, thereby distributing the force transmitted through contact with the pipe more uniformly around the pipe periphery, and distributing the force transmitted through contact with the body more uniformly around the body.

Figs. 7 and 7a show other segment configurations that provide this "self-actuating" feature which provides resistance to pipe pull-out in proportion to the mechanical and/or internal pressure loading applied to the pipe. In particular, the segment 6A comprises a cam-shaped member which is initially pre-loaded via the threaded bolt 7, as discussed previously with regard to segment 6. As the mechanical and/or internal pressure loading increases, and relative movement occurs between the pipe and the restraint assembly, a cam surface 16A rotates against the pipe surface 15 and transfers the load, causing the corner 12 of segment 6A to load against interior corner 13 of the cavity 4. Again, this action occurs independently of the threaded bolt 7. Similarly, the segment 6B comprises a cam-shaped member having a surface texture 16B (e.g., knurled surface) that engages the pipe surface 15. As the mechanical and/or internal pressure loading increases, the textured cam surface 16B of the segment 6B rotates against, and penetrates, the pipe surface 15, and transfers the load, causing the corner 12 of segment 6B to load against interior corner 13 of the cavity 4. Again, this action occurs independently of the threaded bolt 7. Thus, it should be understood that the self-actuating segment of the present invention can be achieved using different segment configurations that are (1) pre-loaded by the threaded bolt 7 and (2) that engage the pipe surface 15 and body 2 to provide resistance to pipe pull-out in proportion to the

mechanical and/or internal pressure loading applied to the pipe, independent of the threaded bolt.

While the invention has been described in detail and with reference to specific examples thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

CLAIMS

WHAT IS CLAIMED IS:

1. A joint restraint assembly for connecting pipe ends together, or to other objects, by gripping the outer surface of the pipe, the joint restraint assembly comprising:

a body encircling the pipe, with said body having a plurality of cavities adjacent the pipe and at least one set of a corresponding plurality of threaded bores disposed through said body, each threaded bore of said at least one set of a corresponding plurality of threaded bores being in communication with a respective cavity;

a segment disposed within each of said cavities in said body, and configured to make contact between said body and the surface of the pipe so as to provide resistance to pipe pull-out in proportion to the mechanical and/or internal pressure loading applied to the pipe; and

a threaded bolt extending through each of said threaded bores to pre-load said respective segment into initial contact with the pipe surface.

2. The joint restraint assembly of Claim 1 wherein the ability of the assembly to resist pipe pull-out at increasing levels of mechanical loading and/or internal pipe pressure is independent of said threaded bolts.

3. The joint restraint assembly of Claim 1 wherein said segment is configured to transmit the load from the pipe to said body while loading said segment primarily in compression.

4. The joint restraint assembly of Claim 3 wherein said segment further comprises at least one edge capable of penetrating the external surface of the pipe.

5. The joint restraint assembly of Claim 4 wherein said at least one edge forms a relief angle, as measured from the pipe surface, that is 25 to 35 degrees, so as to optimize both the structural integrity of the segment edge and the ability of the edge to penetrate the pipe surface.

6. The joint restraint assembly of Claim 3 wherein the circumferential length of all of said segments and their edges comprises a substantial portion of the pipe periphery, thereby distributing the force transmitted through contact with the pipe more uniformly around the pipe periphery, and distributing the force transmitted through contact with the body more uniformly around the body, independently of said threaded bolts.

7. The joint restraint assembly of Claim 1 wherein the shape of the body is optimized to resist the forces imparted to it by contact with said segments, said body comprising:

a substantially cylindrical portion adjacent to the pipe surface with a flange extending radially therefrom; and

wherein said body comprises a shape and wall thickness to compensate for the presence of said cavities to maintain the strength and rigidity of said body.

8. The joint restraint assembly of Claim 1 further comprising an elastomeric material positioned between each of said segments and their corresponding cavities, said elastomeric material disposing said segment in said cavity in an optimum position for self-actuation or for retaining said segment in said cavity for shipping, handling and installation.

9. The joint restraint assembly of Claim 1 wherein said segment comprises a cam surface that engages and rotates against the pipe surface to resist pipe pull-out at comparatively high levels of mechanical loading and/or internal pipe pressure in proportion to the loading.

10. The joint restraint assembly of Claim 9 wherein the ability of the assembly to resist pipe pull-out at increasing levels of mechanical loading and/or internal pipe pressure is independent of said threaded bolts.

11. The joint restraint assembly of Claim 9 wherein said segment is configured to transmit the load from the pipe to said body while loading said segment primarily in compression.

12. The joint restraint assembly of Claim 1 wherein said cam surface further comprises a surface texture for engaging the pipe surface.

13. The joint restraint assembly of Claim 12 wherein the ability of the assembly to resist pipe pull-out at increasing levels of mechanical loading and/or internal pipe pressure is independent of said threaded bolts.

14. The joint restraint assembly of Claim 12 wherein said segment is configured to transmit the load from the pipe to said body while loading said segment primarily in compression.

15. A method for providing a joint restraint assembly with resistance to pipe pull-out in proportion to the mechanical and/or internal pressure loading applied to a pipe, said method comprising the steps of:

providing a body that encircles the pipe wherein the body has a plurality of cavities and at least one set of a corresponding plurality of threaded bores disposed through said body, said cavities being disposed adjacent the pipe;

disposing a segment within each of said cavities;

pre-loading each segment against the pipe by rotating a corresponding bolt disposed in each threaded bore of said at least one set of a corresponding plurality of threaded bores;

permitting said segment to move within said cavity, independently of said bolts, in response to pipe pull-out forces, said segment being self-actuating and orienting itself so that said segment is in contact with said body and said pipe surface and generates a resistance to the pipe pull-out forces in proportion to the mechanical and/or internal pressure loading applied to a pipe.

16. The method of Claim 15 wherein said step of generating a resistance comprises loading said segment primarily in compression between said body and said pipe surface.

17. The method of Claim 16 wherein said step of permitting said segment to move within said cavity comprises said segment being self-actuating and orienting itself to drive a segment edge, that has been pre-loaded to penetrate the pipe surface, deeper into the pipe surface while another portion of said segment lodges against an inside surface of said cavity.

18. The method Claim 16 wherein said step of permitting said segment to move within said cavity comprises a cam surface rotating against the pipe surface until a first portion of said segment lodges against an inside surface of said cavity.

ABSTRACT OF THE DISCLOSURE

A joint restraint assembly for connecting pipe ends together, or to other objects, which includes a body encircling the pipe. The body has a plurality of cavities adjacent to the pipe with a segment configured to fit into each cavity. One or more threaded bores are disposed through the body into each cavity. A threaded bolt extends through each threaded bore to engage the segment in that cavity, and to pre-load the segment against the pipe when assembled thereon. Mechanical or pressure loading, tending to pull the pipe out of the restraint assembly, causes the segment to self actuate, and the application of increasing load causes a proportional increase to the force engaging the segment to the pipe. The joint restraint assembly reliably accommodates comparatively high levels of mechanical loading and/or pipe internal pressure, and does so without relying upon the limited force produced by the threaded bolt pre-load on the segments at the time of assembly.

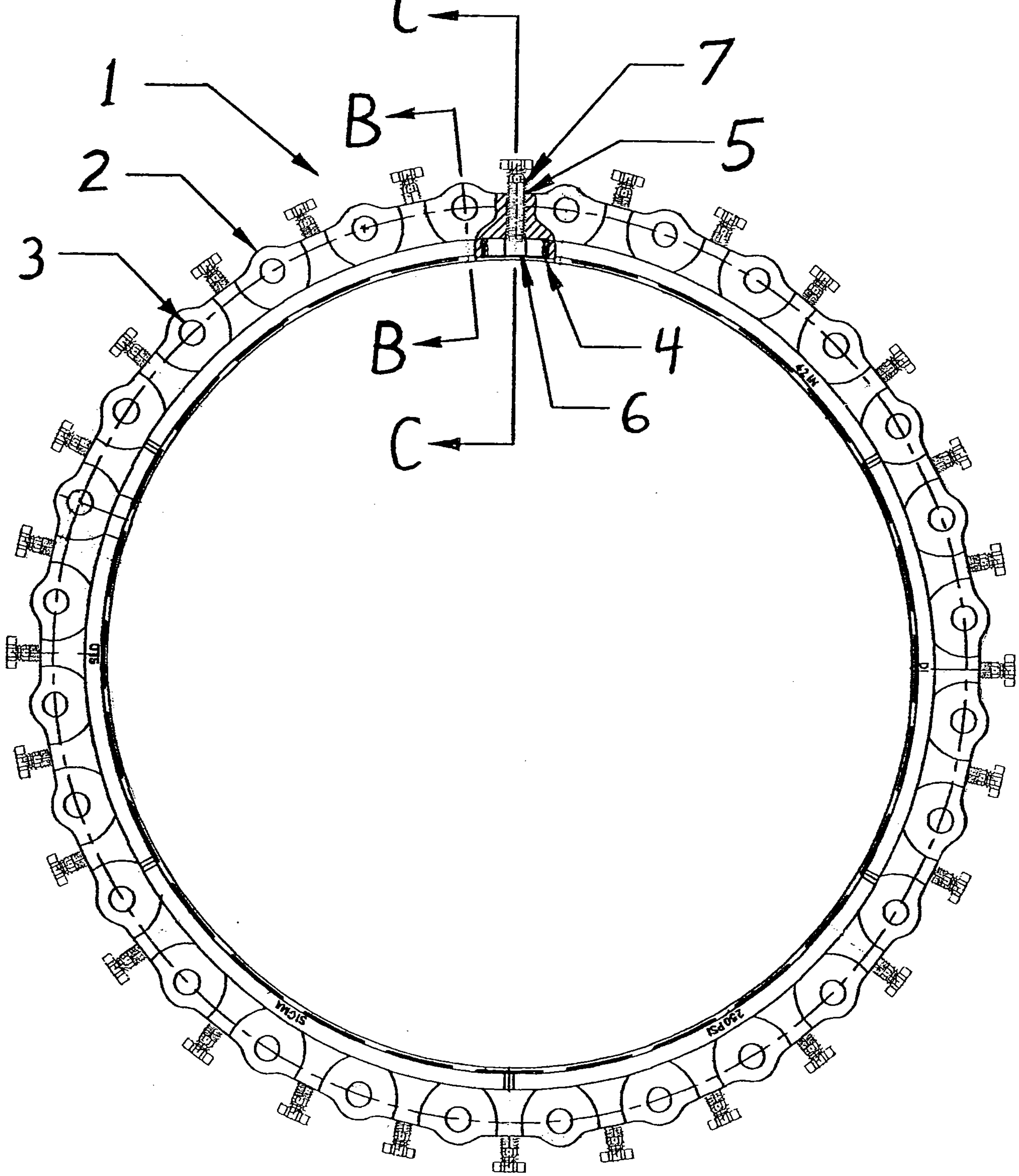


Fig. 1

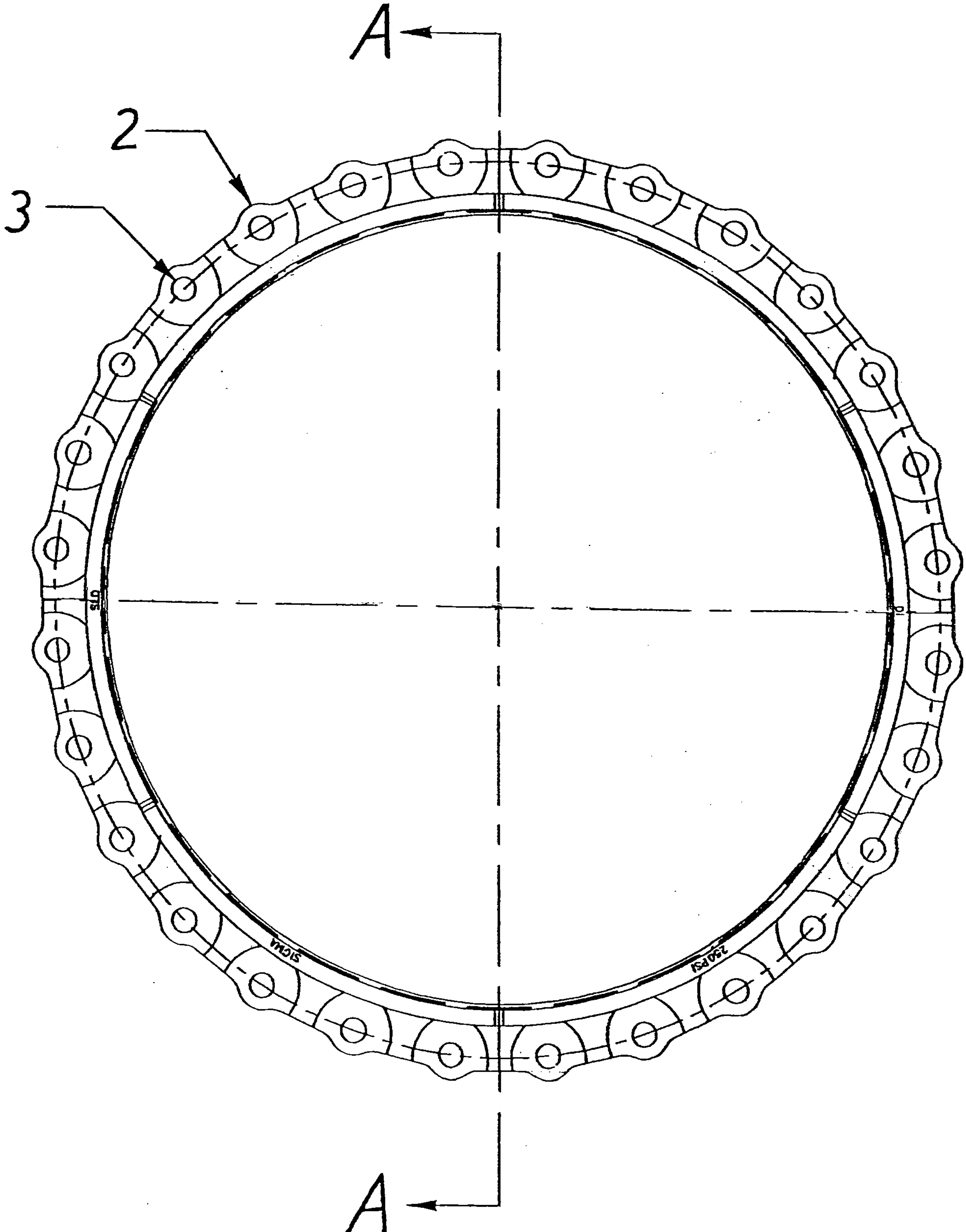


Fig 1a

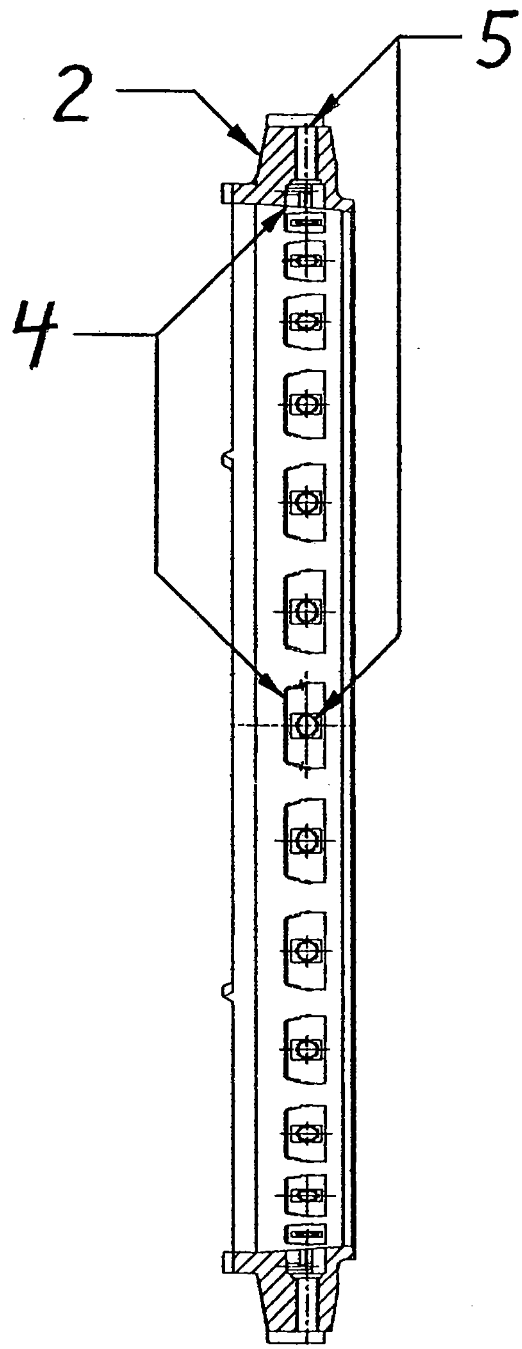


Fig. 2

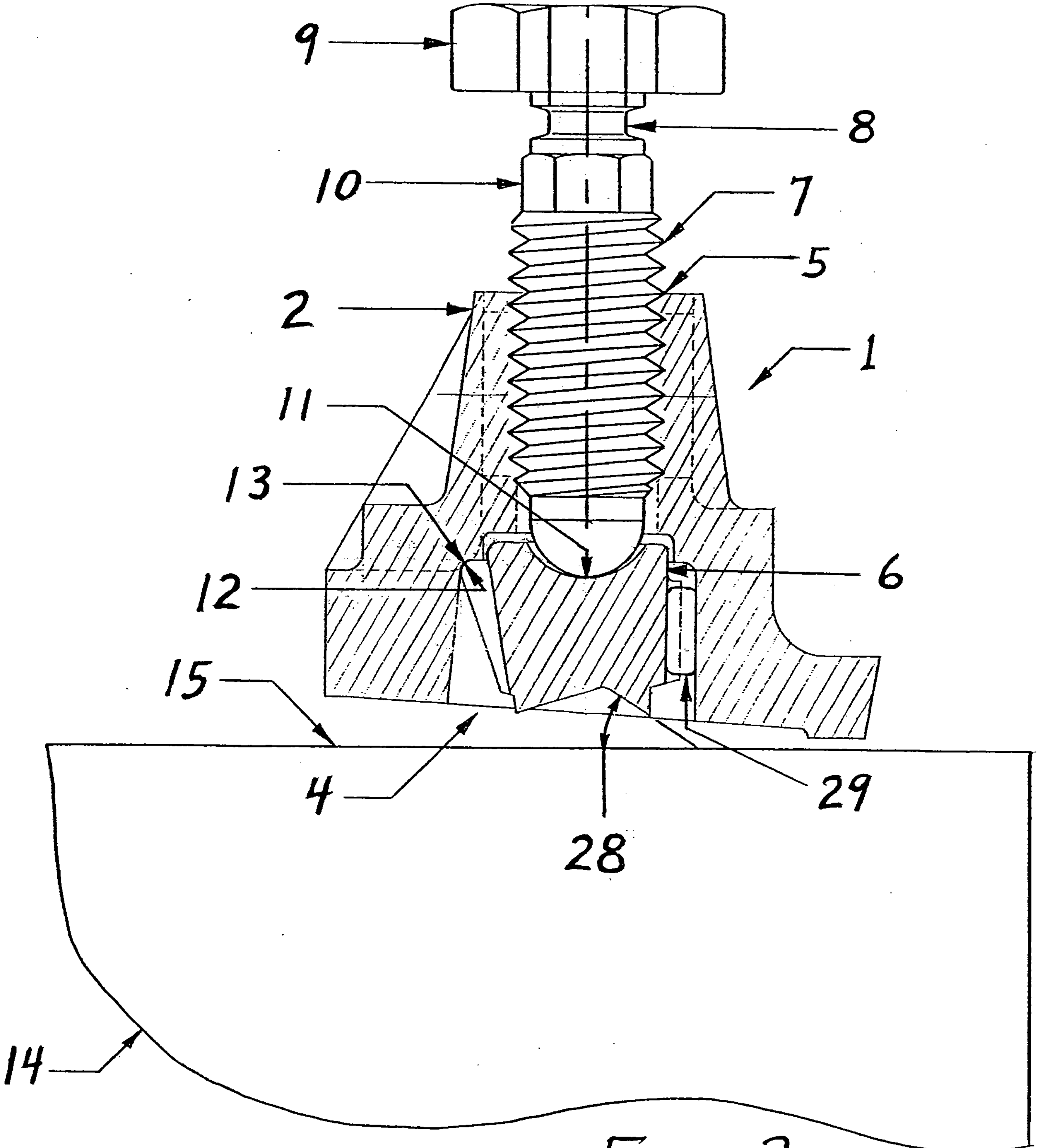


Fig. 3

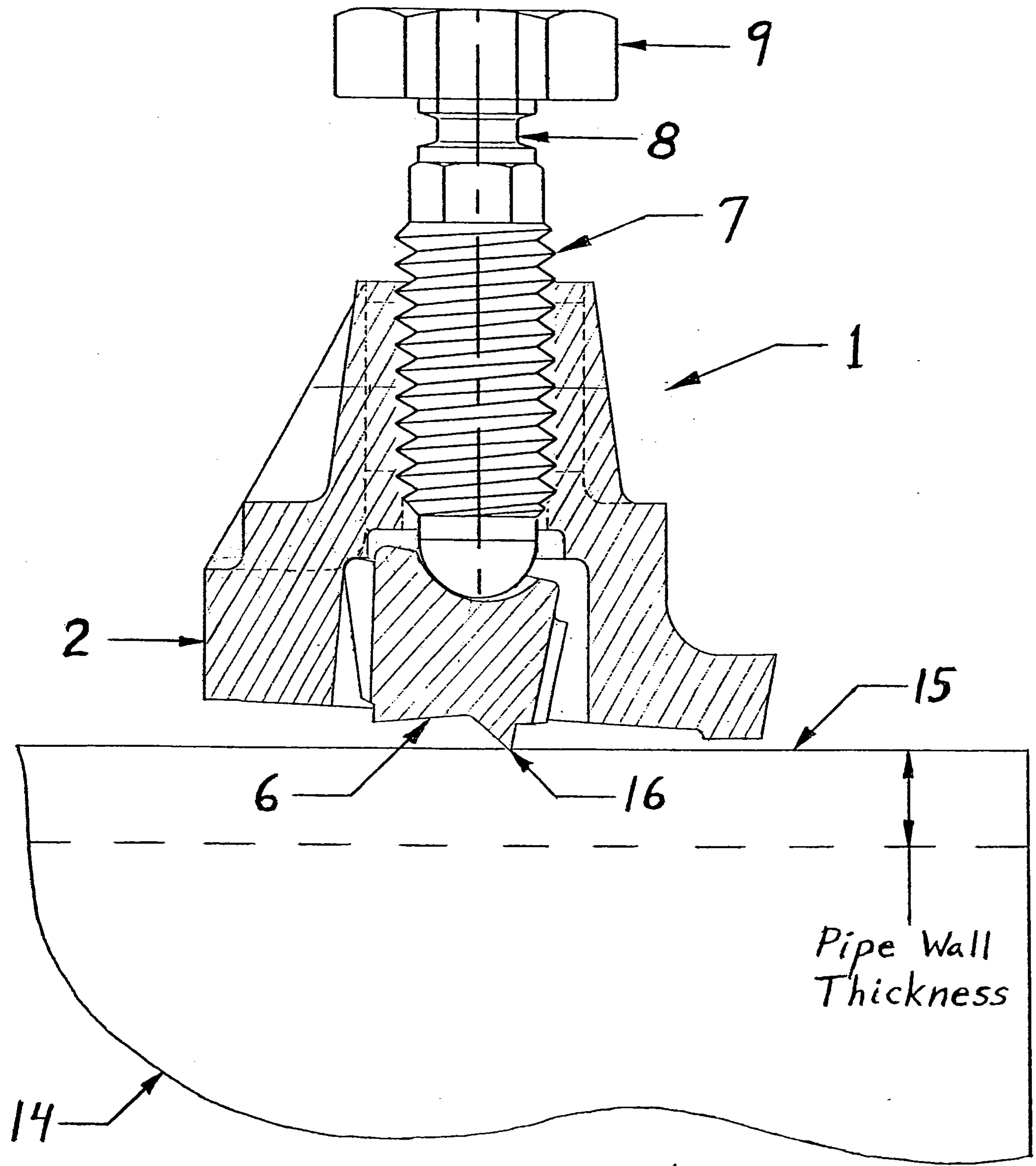
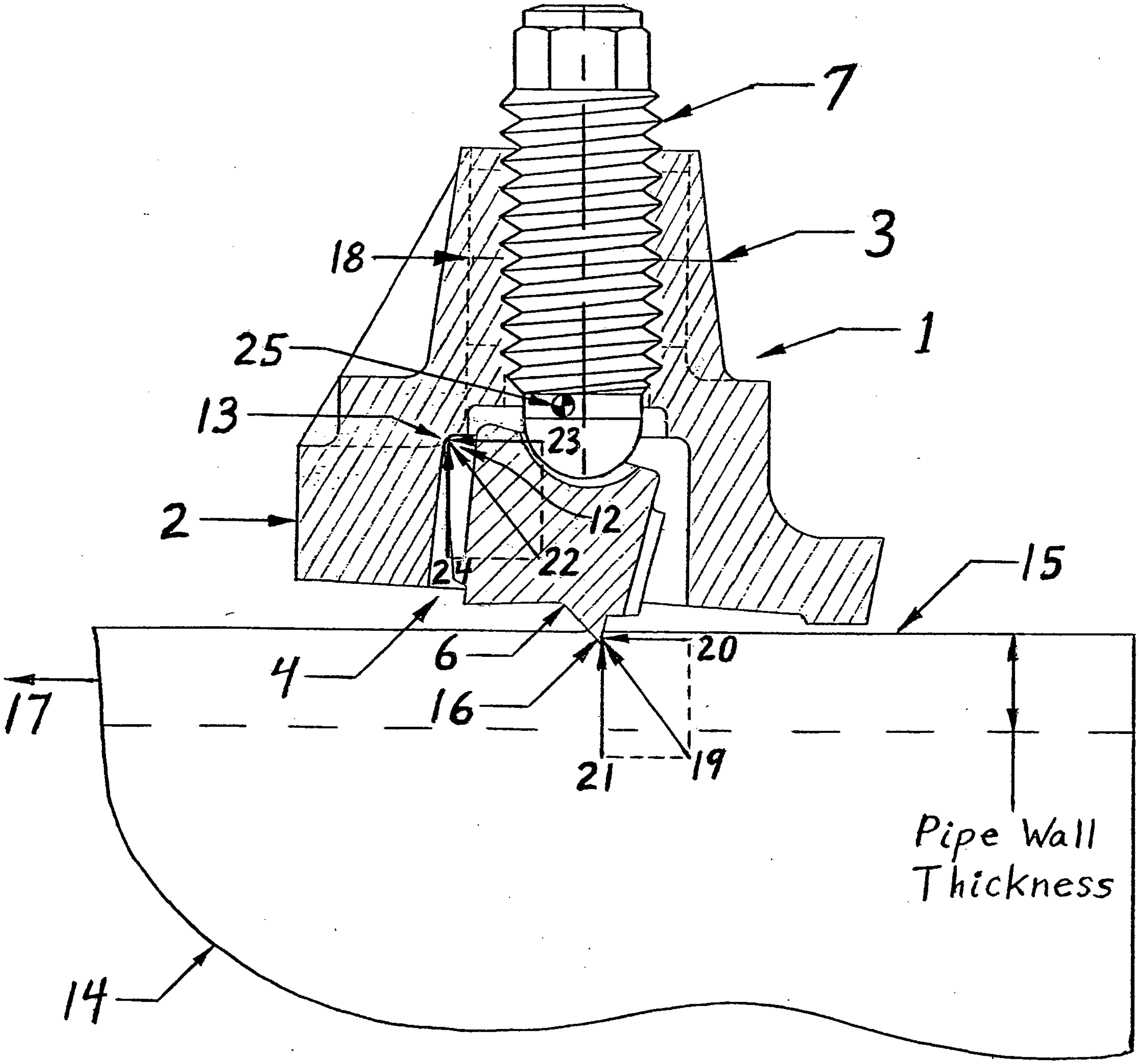


Fig. 4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Pipe Wall
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Fig. 5

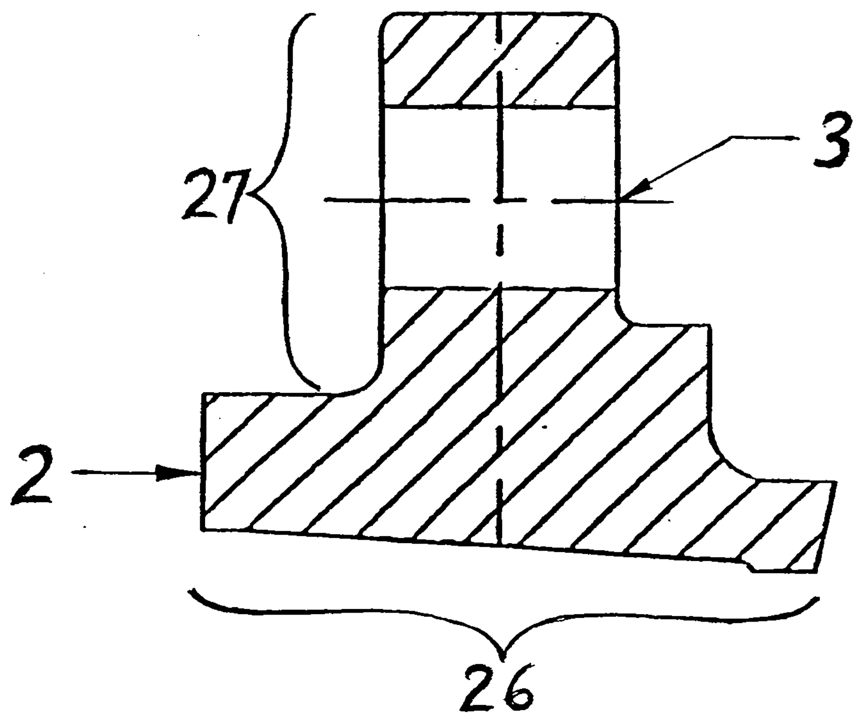

Fig. 6

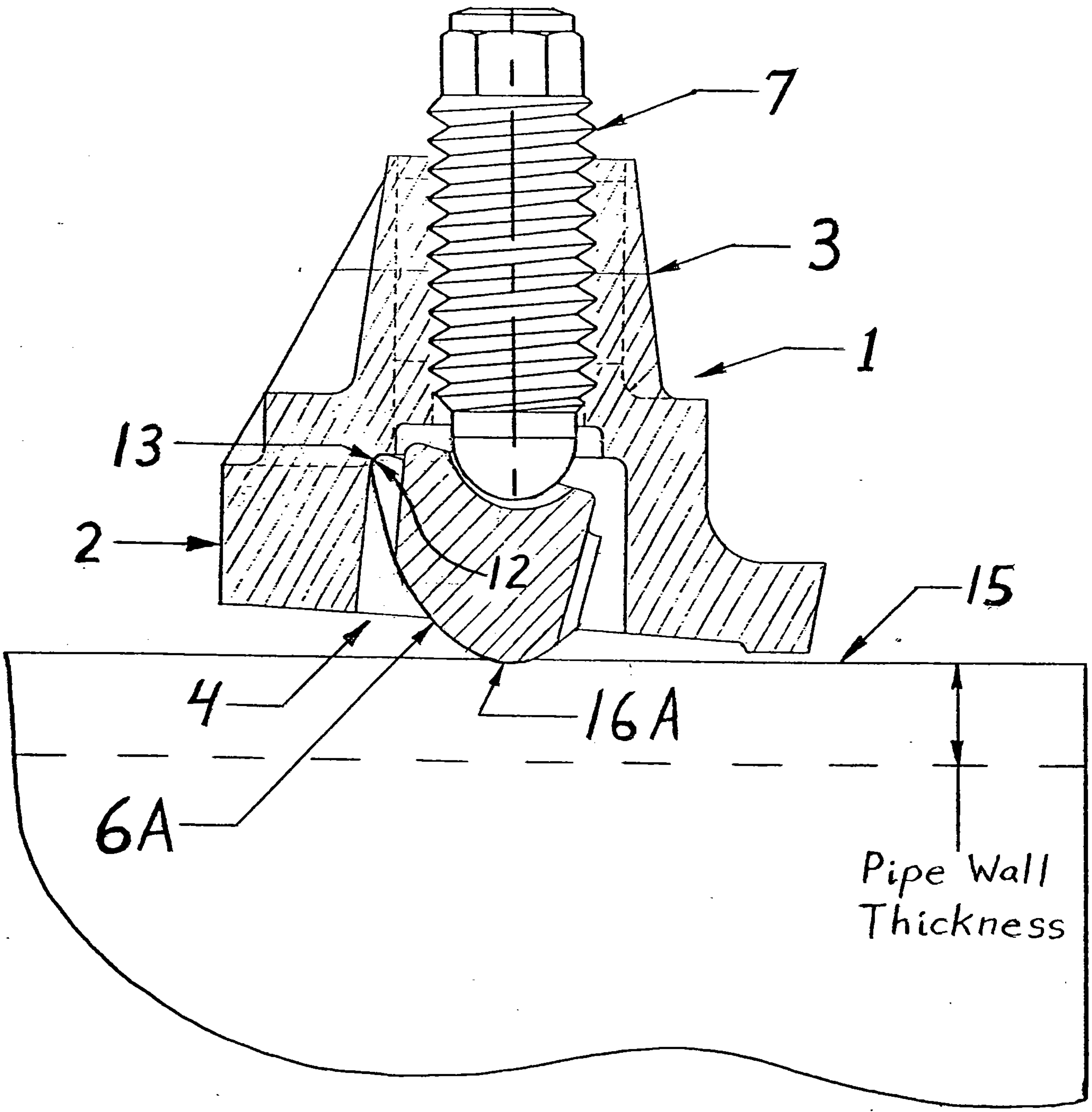

Fig. 7

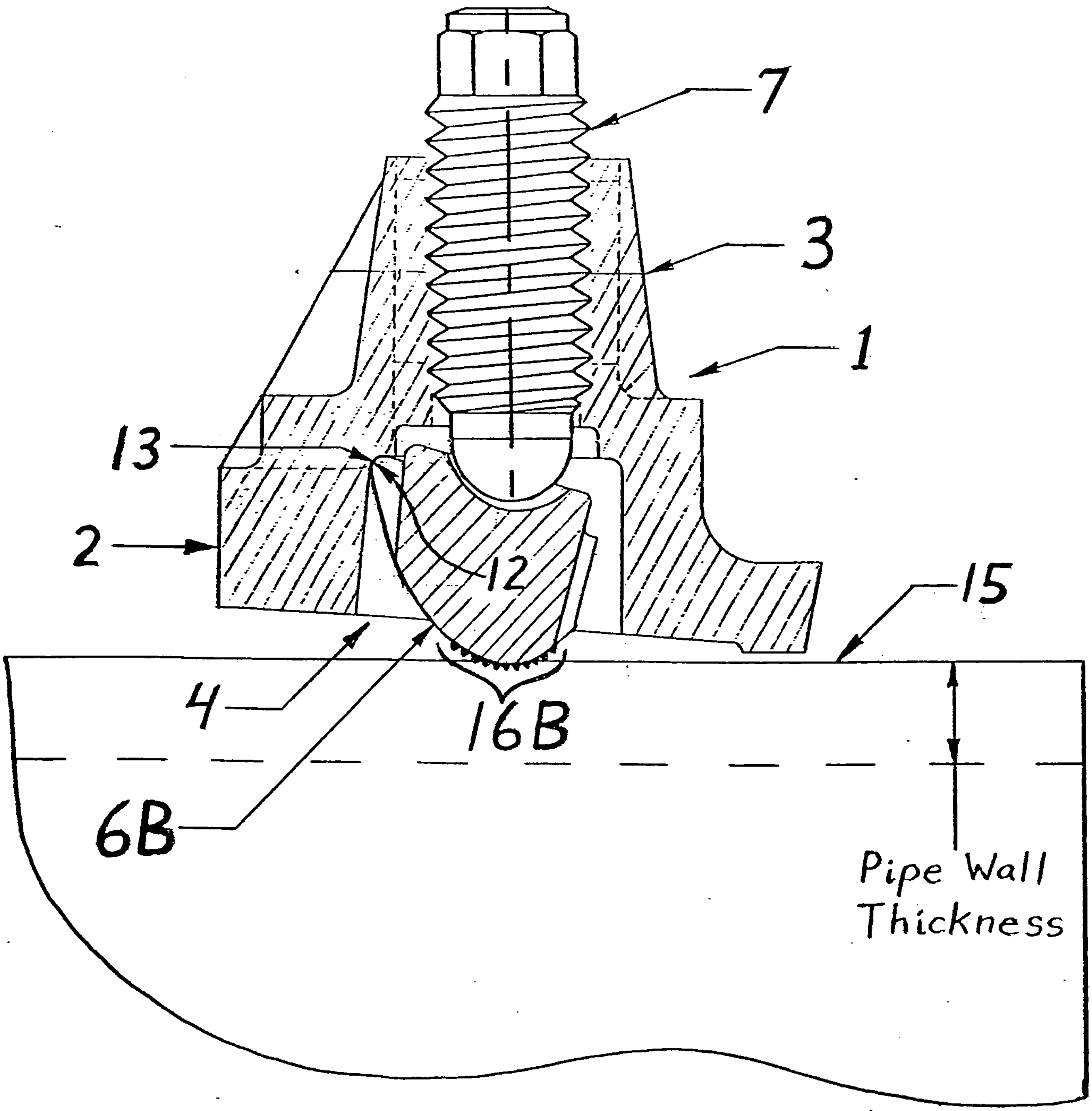

Fig. 7a

US006173993B1

(12) United States Patent
Shumard et al.

(10) Patent No.: **US 6,173,993 B1**
(45) Date of Patent: **Jan. 16, 2001**

(54) **JOINT RESTRAINT**

(75) Inventors: **Dennis D. Shumard; Michael L. Lundstrom**, both of Eastland, TX (US)

(73) Assignee: **EBAA Iron, Inc.**, Eastland, TX (US)

(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **09/254,408**

(22) PCT Filed: **Sep. 5, 1997**

(86) PCT No.: **PCT/US97/15663**

§ 371 Date: **Jun. 11, 1999**

§ 102(e) Date: **Jun. 11, 1999**

(87) PCT Pub. No.: **WO98/10211**

PCT Pub. Date: **Mar. 12, 1998**

Related U.S. Application Data

(60) Provisional application No. 60/025,571, filed on Sep. 6, 1996.

(51) **Int. Cl.**^{7} **F16L 17/00**

(52) **U.S. Cl.** **285/23**; 285/337; 285/404

(58) **Field of Search** 285/23, 337, 368, 285/374, 404, 421

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Primary Examiner—Dave W. Arola
(74) *Attorney, Agent, or Firm*—Randall C. Brown; Alvin R. Wirthlin; Akin, Gump, Strauss, Hauer & Feld, L.L.P.

(57) **ABSTRACT**

A joint restraint (**10**) for securing a first pipe (**12**) to a second pipe. The joint restraint (**10**) includes an annular body (**14**) and a plurality of wedge housings (**18**) extending from the annular body (**14**) and characterized by open rear faces (**38**) to allow coreless casting. A bolt (**32**) is disposed within a hole (**30**) in each wedge housing (**18**) and a wedge (**40**) is disposed within each wedge housing (**18**). Each wedge (**40**) has a bolt-actuated tooth (**52**), a larger pressure-actuated tooth (**54**), a top surface (**44**) having a groove (**48**) adapted to slidably receive a bolt actuator (**32**), and a bottom surface (**42**) that is partially tapered to act as a bearing (**76**) limiting the extent of bolt-driven actuation.

36 Claims, 6 Drawing Sheets

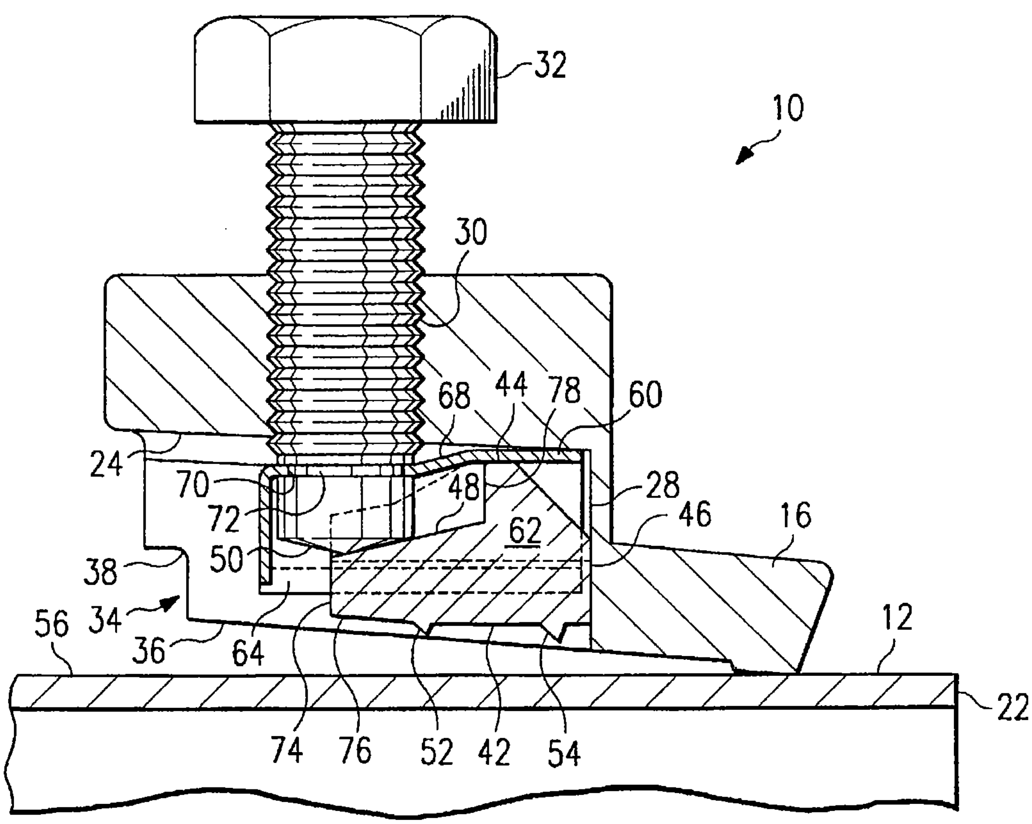

FIG. 1

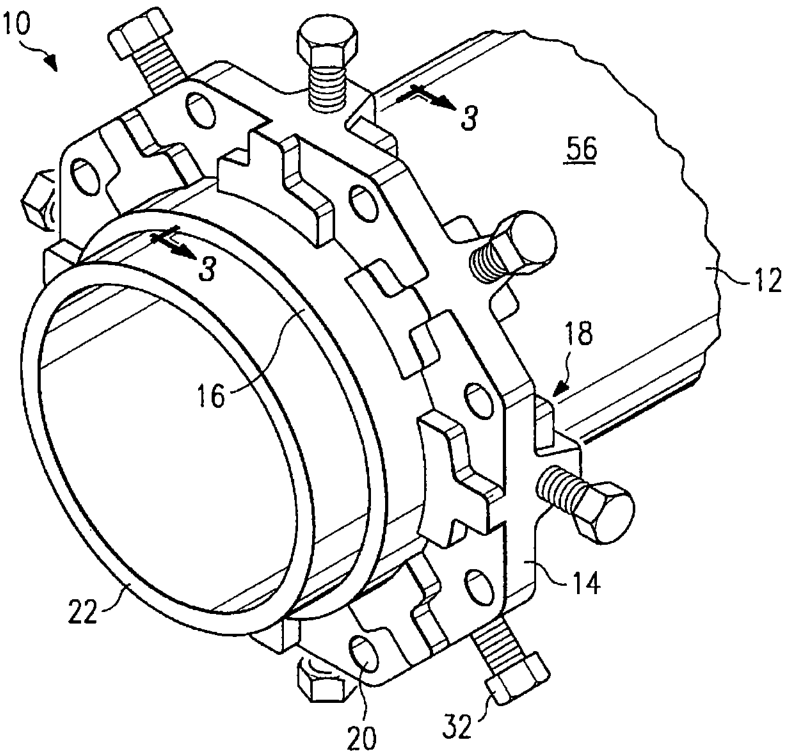
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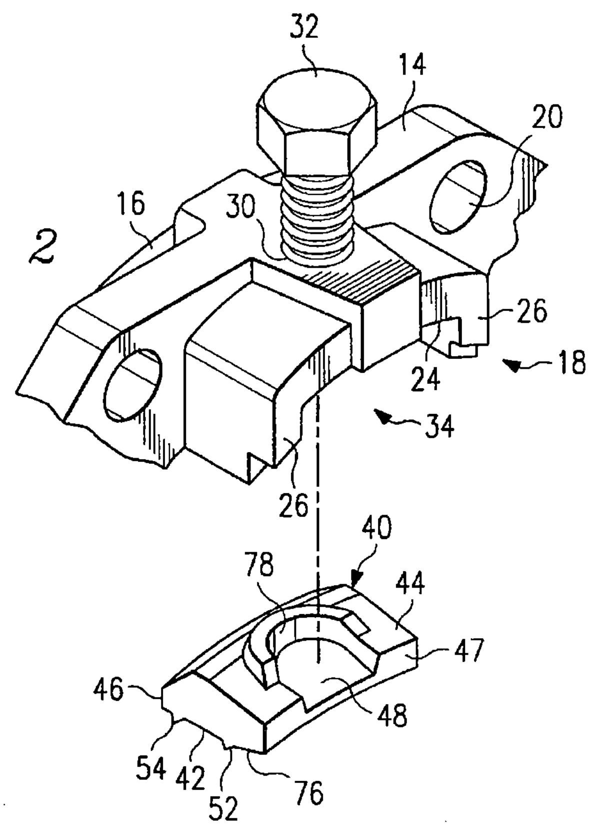
FIG. 2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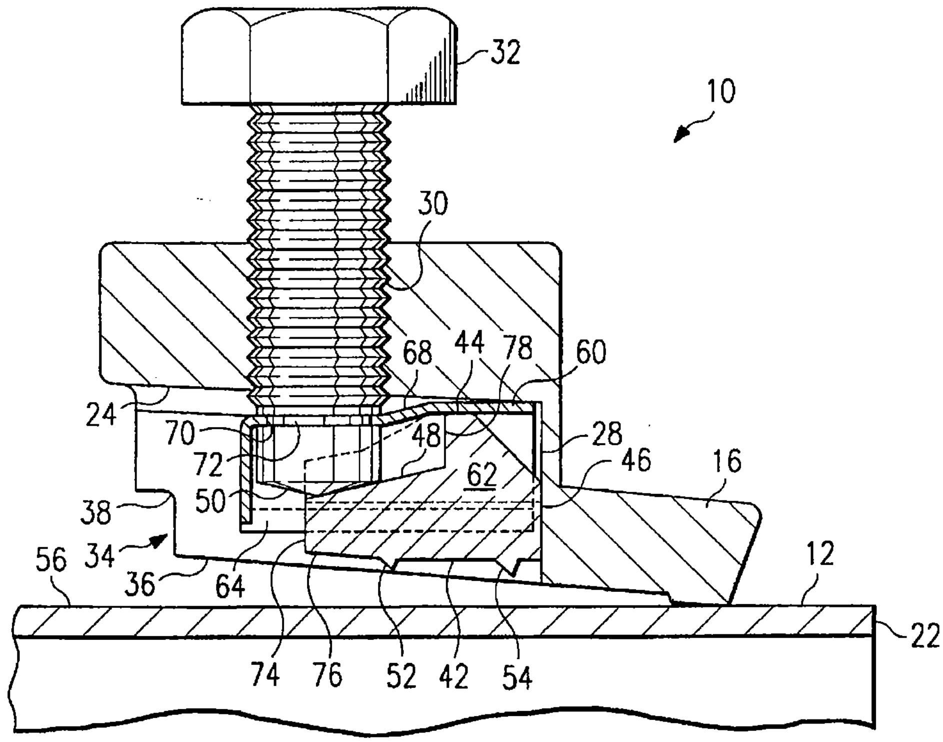
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FIG. 3

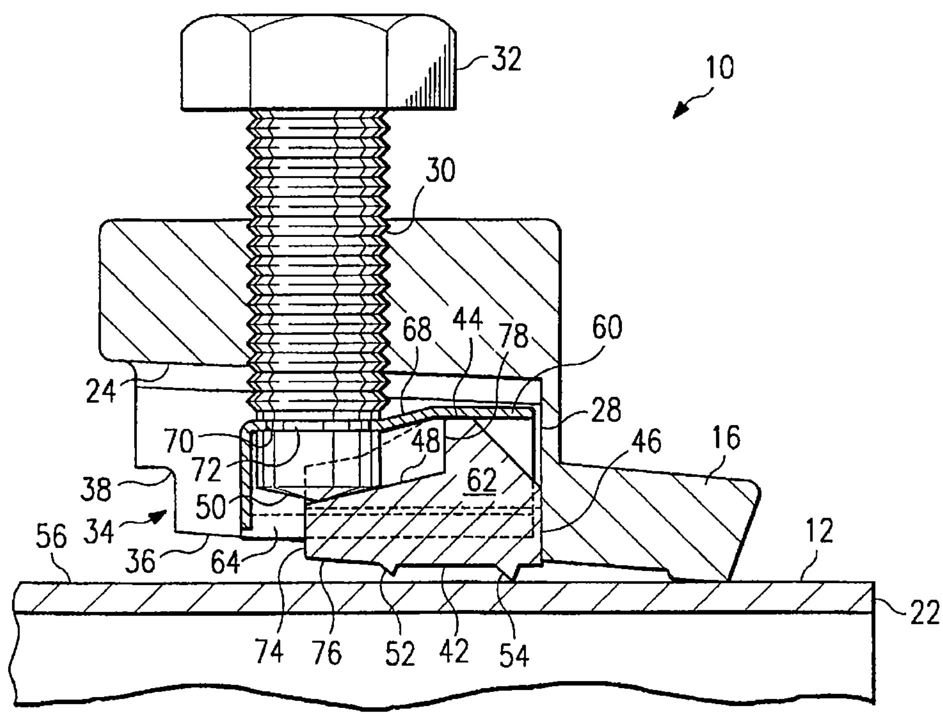
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FIG. 4

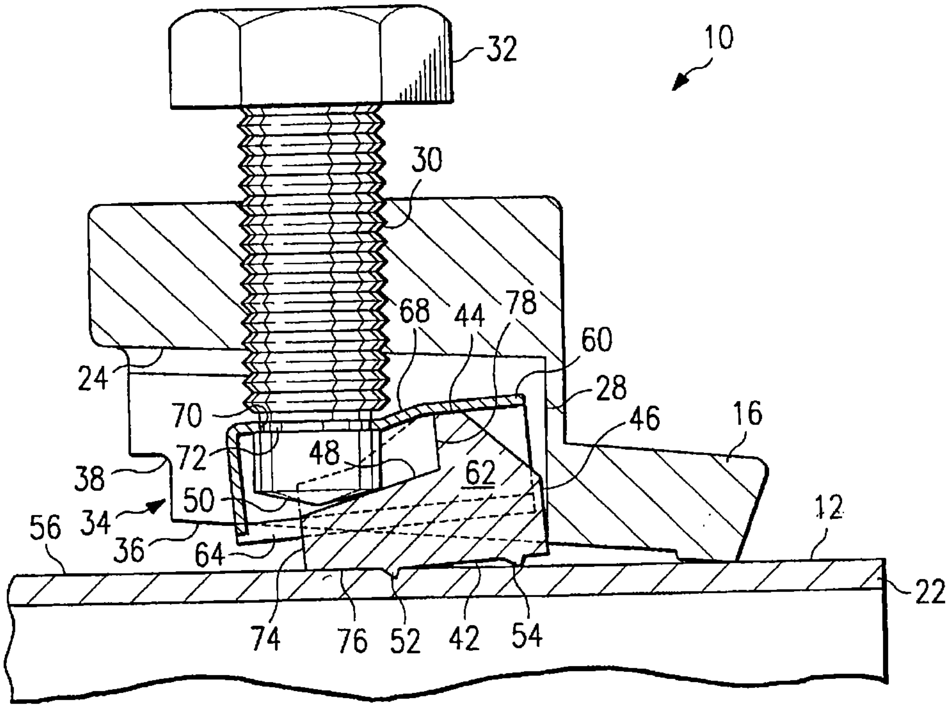
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FIG. 5

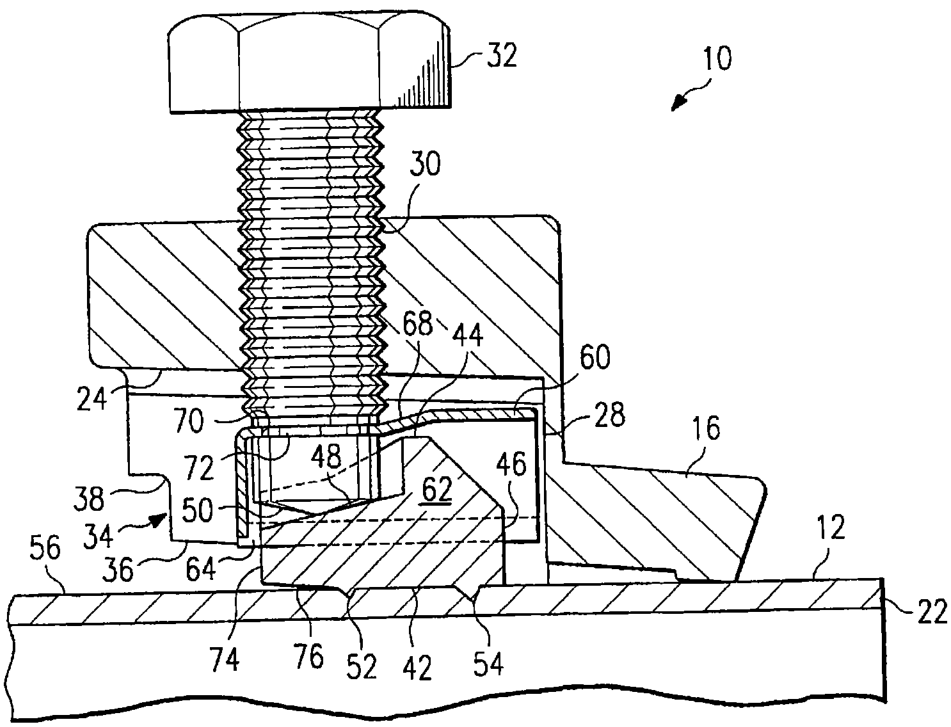
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FIG. 6

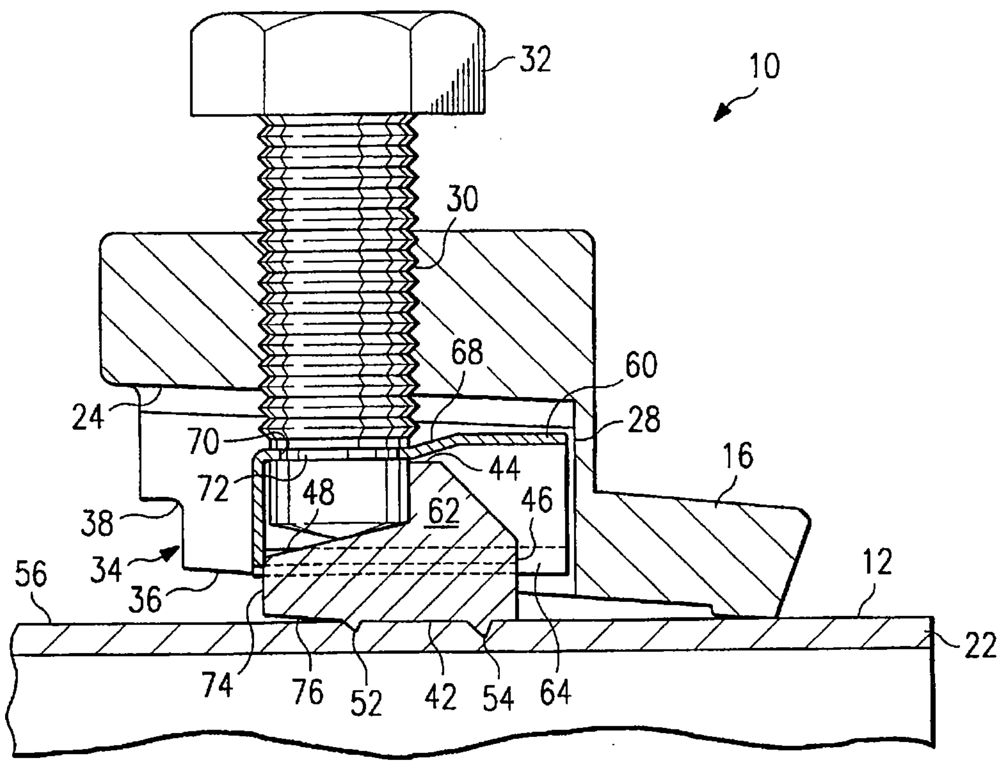
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FIG. 7

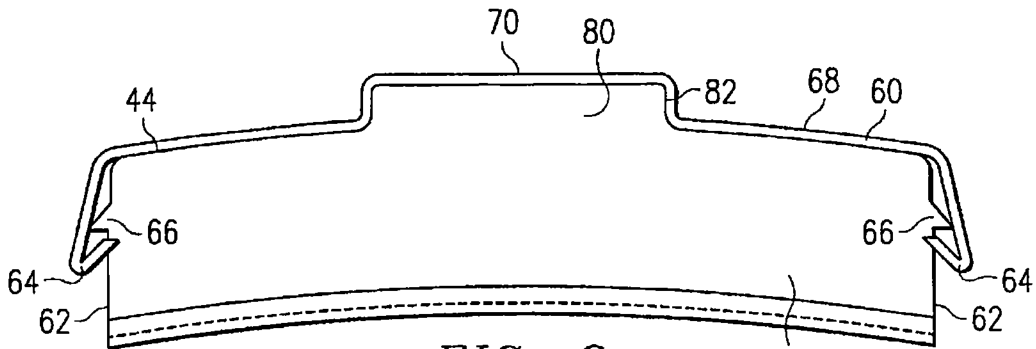

FIG. 8

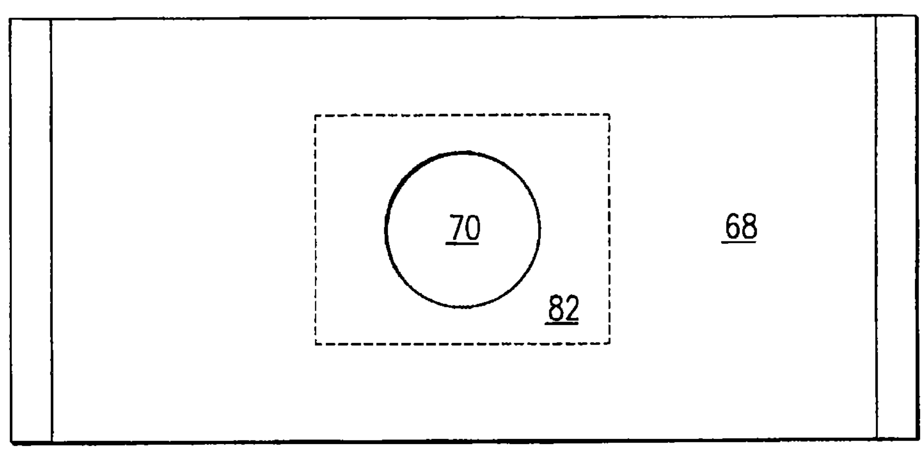

FIG. 9

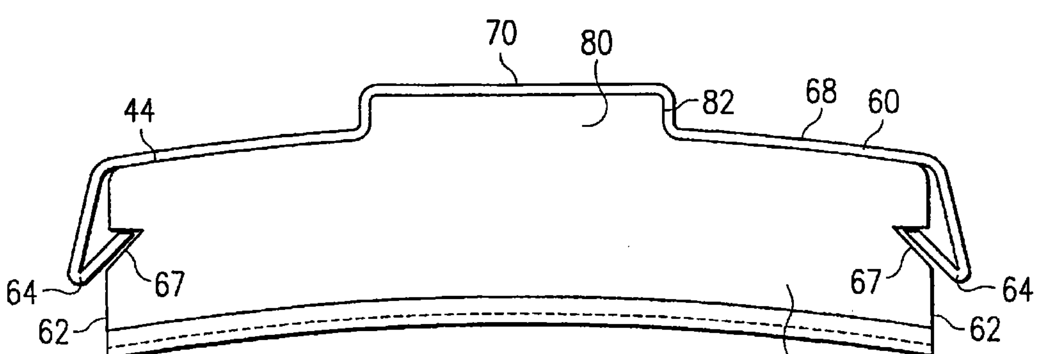

FIG. 10

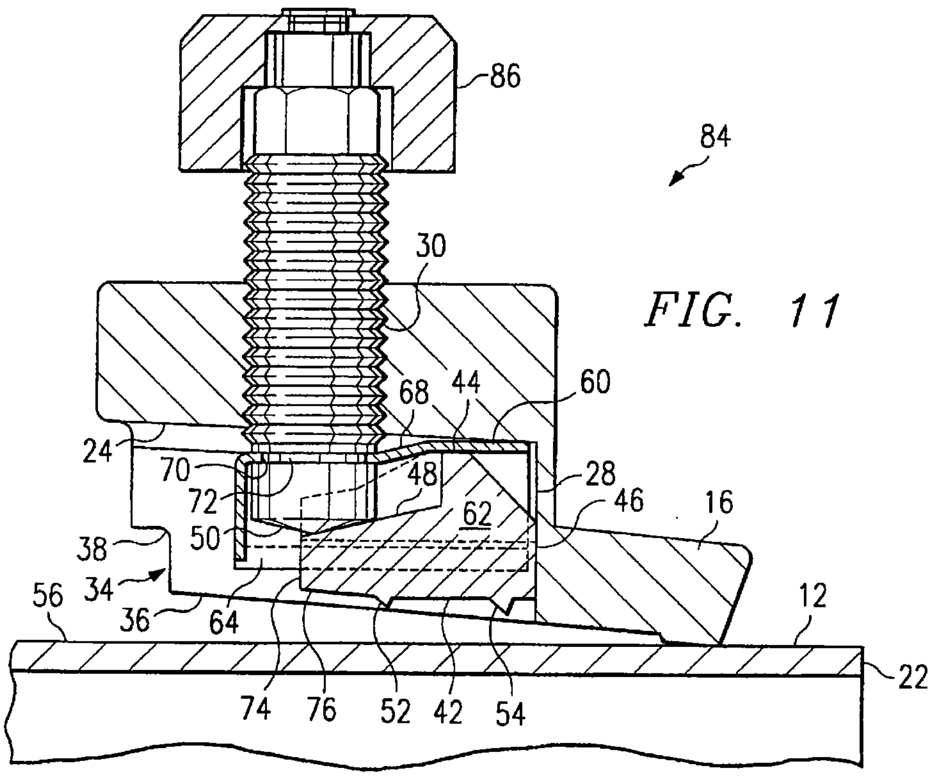
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FIG. 11

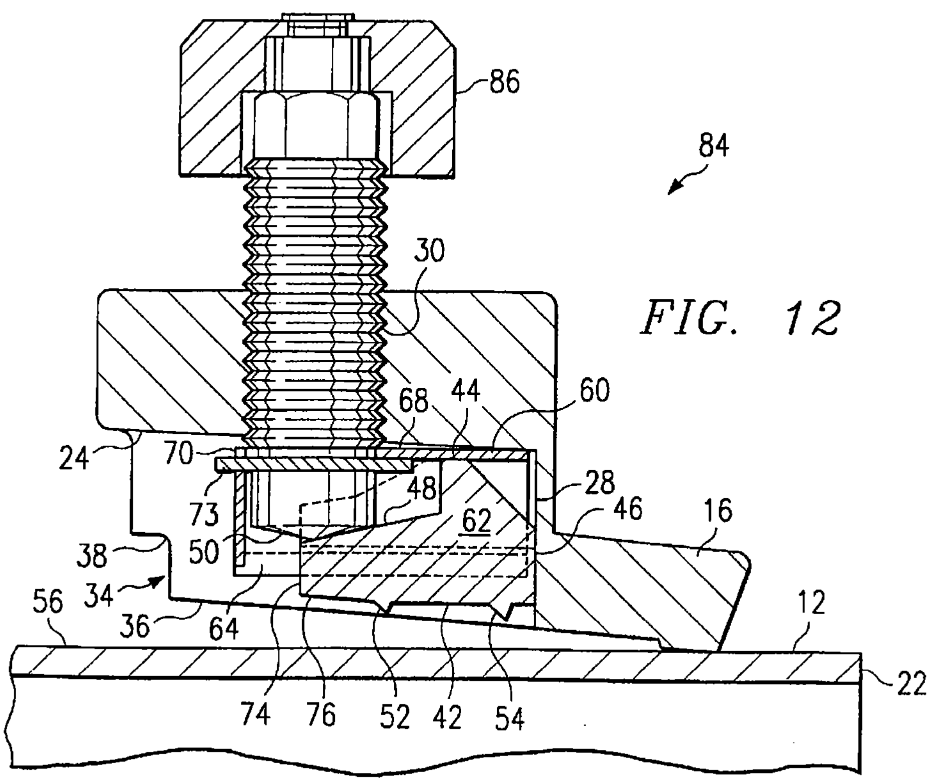
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FIG. 12

JOINT RESTRAINT

This application claims benefit to provisional application Ser. No. 60/025,571 filed Sep. 6, 1996.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a joint restraint for connecting a pair of axially aligned pipes and/or appurtenances such that a tight fit and suitable seal are formed therebetween, and such that protection is provided against the disengagement that could occur when force is applied in the axial direction.

2. Description of Related Art

It is known to employ a joint restraint to prevent disengagement of axially aligned pipes and/or appurtenances. For purposes of this application, pipes and/or appurtenances shall be referred to herein collectively as "pipes" or in the singular as "pipe". Typically, a joint restraint comprises an annular body from which a plurality of evenly spaced wedge housings axially extend. The annular body encircles the outer surface of a first pipe, and is engaged therewith using actuatable wedges held within each of the wedge housings. The annular body is also connected to an integral flange disposed at the terminus of a second pipe, so as to hold the first and second pipes together.

Examples of joint restraints, the pipes with which they function and associated equipment may be found in U.S. Pat. No. 4,092,036 to Sato et al. ("Sato '036"), U.S. Pat. No. 5,071,175 to Kennedy, Jr. ("Kennedy '175"), and U.S. Pat. No. 5,544,922 to Shumard et al. ("Shumard '922"), the entire disclosures of which are incorporated herein by reference.

Joint restraints used in the past have suffered from several disadvantages that have diminished their functionality and ease of use, and that have resulted in increased manufacturing costs. For example, many joint restraints employed in the past required the use of sand cores in casting the wedge housings. Because the use of such sand cores increases processing time and expense, it is desirable to employ a design that minimizes or eliminates the need for such sand cores.

Another disadvantage of joint restraints employed in the past is diminished or unpredictable performance with plastic pipe (e.g., PVC). Many joint restraints rely on friction between a gripping surface or mechanism such as wedges, wedge rings and serrated split rings and the pipe surface to secure the pipe. However, the behavior of such friction-based means is unpredictable when used with PVC, and the friction force that may be induced is limited.

The Kennedy '175 joint restraint addresses this problem by employing a wedge having pipe-engaging teeth that may be driven into engagement with the pipe surface. The Kennedy '175 joint restraint, however, has several disadvantages. Specifically, the design requires the use of sand cores in casting, the design lacks a reliable method of keeping the wedge in place and the wedge does not retract when the actuating screw is retracted.

The Kennedy '175 disclosure contemplates the use of a twist-off bolt to reduce the possibility of preventing the wedge from being over-torqued during initial actuation. Ideally, however, the wedge itself should resist further intrusion into the pipe surface after the initial actuation groove is formed.

Another disadvantage of conventional joint restraints is their lack of flexibility. For example, in the Kennedy '175

patent, once the joint restraint is installed on the pipe, the position of the wedges is fixed, other than a relatively minor amount of radial play, with respect to their respective wedge housings. It is desirable to allow the wedges some freedom to move within their respective housings independently of the joint restraint in order to increase the capacity of the system to accommodate joint deflection resulting from settlement or other force on the pipes. Likewise, it is advantageous to allow some play in the radial displacement of an installed wedge in order to accommodate greater variations in pipe size without the need for shims or spacers.

Yet another disadvantage of conventional joint restraints is the typical lack of means for retaining wedges or other restraint means in their respective housings prior to installation in the field. Such retaining means are desirable in order to allow preassembly of wedges into a joint restraint, and to reduce the likelihood of subsequent wedge loss.

A need exists, therefore, for a simple and robust joint restraint that provides reliable restraint, that minimizes the use of cores in molding, that is easy to assemble, install and use, and that is multi-functional and flexible with respect to pipe size and type. Such a device should also provide a mechanism for retaining wedges in their housings prior to or after installation.

SUMMARY OF THE INVENTION

The apparatus of the present invention overcomes the above-mentioned disadvantages and drawbacks which are characteristic of the related art.

In a preferred embodiment, the joint restraint of the present invention comprises an annular body having a plurality of axially extending wedge housings. The annular body is adapted to encircle and engage the end of a first pipe, and to connect to the terminal flange of a second pipe in the manner contemplated by the Sato '036 and Kennedy '175 patents. In a preferred embodiment, the wedge housings are uniformly distributed around the annular body and each wedge housing defines a pocket adapted to receive a bolt and a wedge.

In a preferred embodiment, the pocket defined by the wedge housing has no radially inner surface, being bounded instead by the outer surface of the first pipe when installed. In a preferred embodiment, the wedge pocket face opposite the annular extension is also open, allowing for coreless casting of the wedge housings.

In a preferred embodiment, a bolt hole passes through the radially outer wall of the wedge pocket. During actuation, the bolt is inserted through the hole, into the wedge pocket and towards the pipe. Preferably, the hole and bolt are threaded so that the bolt may be threadedly engaged within the bolt hole. The wedge, which is disposed between the end of the bolt and the pipe surface, is thus acted upon by the bolt.

Each wedge comprises a radially outer top surface, a front surface which faces into the pocket, an opposite rear surface, two side surfaces, and a bottom surface. The top surface of the wedge is adapted to receive the end of the bolt. Preferably, a groove is disposed in the top surface of the wedge and is adapted to receive the end of the bolt. The groove preferably inclines with respect to the bottom surface from the rear surface to the front surface of the wedge. As the end of the bolt moves from the rear surface to the front surface of the wedge, the wedge exerts an increasing grip on the pipe. The orientation of the groove is such that, in an initial set position, the groove at the rear surface of the wedge is radially closer to the pipe surface than the groove at the front surface of the wedge.

In a preferred embodiment, the bottom surface of the wedge is curved to correspond to the curvature of the outer surface of the pipe, and comprises two parallel pipe-engaging teeth. The first tooth is disposed below the groove and is adapted to penetrate the pipe surface upon initial actuation of the wedge.

In a preferred embodiment, the second tooth is disposed between the first tooth and the front of the wedge. The second tooth is larger than the first, and only penetrates the pipe surface after pressurization. Although the second tooth may contact the pipe surface before the first tooth during actuation, the second tooth does not penetrate the pipe surface. Instead, the wedge rotates to focus penetrating force at the first tooth.

In a preferred embodiment, a tapered portion at the bottom of the wedge extends from the first tooth to the rear surface of the wedge and acts as a large bearing area when the bolt operates upon the wedge. The bearing is seated against the pipe surface when the first tooth is fully embedded, and provides resistance to further torque on the bolt by distributing the load over a large surface.

Once the wedge is actuated, motion of the first pipe away from the second pipe causes the first pipe to shift relative to the annular body. This is because the connection between the annular body and the flanged end of the second pipe is relatively rigid. The wedge, on the other hand, has a tooth that is embedded in the first pipe, and accordingly tends to travel with the first pipe. As a result, the bolt and annular body slide forward relative to the groove in the wedge.

Forward motion of the bolt in the groove causes the wedge to pivot about the embedded first tooth, and, with sufficient force, causes the larger second tooth to penetrate the pipe surface. When the bolt reaches the front edge of the groove, further motion of the pipe is prevented by interference between the front edge and the bolt. In a preferred embodiment, the interference contact area is increased by adding a raised lip at the front edge of the groove. The raised lip also prevents the wedge from rotating out from under the bolt at high thrust forces.

In a preferred embodiment, retaining means are employed to allow wedges to be held within their respective wedge housings prior to installation. The retaining means preferably comprise a shroud which forms a partial shell around the wedge. The retaining means also preferably hold the wedge in the proper location relative to the bolt regardless of the location of the bolt hole or the deflection of the joint between the first pipe and the second pipe.

In a preferred embodiment, the shroud is secured to the wedge by hooking upturned edges around flanges disposed on the side surfaces of the wedge. In another preferred embodiment, the shroud is secured to the wedge by inserting the upturned edges into grooves disposed on the side surfaces of the wedge. In each of these embodiments, an aperture disposed in the shroud above the groove of the wedge is then disposed on the end of the bolt. The shroud is designed to deform during actuation and operation of the joint restraint, in order to allow rotation and displacement of the wedge.

In another preferred embodiment, the bottoms of the sidewalls of the wedge housing pockets closest to the pipe have projections or grooves in the pocket area. In this embodiment, the shroud engages the projections or grooves to maintain the position of the wedge in the wedge housing pockets.

In still another preferred embodiment of the present invention, the end of the bolt is engaged with the wedge to keep the wedge from coming out of the open back of the pocket. Also a mechanism may be incorporated into the shroud that allows the wedge to spring back into the pocket when the joint restraint is removed from the pipe.

In still another embodiment of the present invention, the shroud is engaged with the wedge, extends within the wedge housing pocket and has a portion that extends out of the wedge pocket and engages with the annular body to maintain the wedge in the wedge pocket.

In a still further embodiment of the present invention, a groove is disposed in the bottom of the wedges and a ring is placed within each groove that interacts with walls of the wedge pocket to maintain each wedge in the wedge pocket.

Numerous objects, features and advantages of the present invention will be readily apparent to those of ordinary skill in the art upon a reading of the following detailed description of presently preferred, but nonetheless illustrative, embodiments of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a joint restraint according to the present invention;

FIG. **2** is an exploded perspective view of a wedge and a wedge housing according to the present invention;

FIG. **3** is a section view of the joint restraint shown in FIG. **1** prior to actuation;

FIG. **4** is a section view of the joint restraint shown in FIG. **1** during actuation;

FIG. **5** is a section view of the joint restraint shown in FIG. **1** subsequent to actuation;

FIG. **6** is a section view of the joint restraint shown in FIG. **1** after pressurization;

FIG. **7** is a section view of the joint restraint shown in FIG. **1** at high pressure;

FIG. **8** is a section view of a wedge and shroud according to the present invention;

FIG. **9** is a top plan view of a shroud according to the present invention;

FIG. **10** is a section view of an alternate wedge and shroud according to the present invention;

FIG. **11** is a cross section view of an alternate bolt according to the present invention; and

FIG. **12** is a cross section view of another alternate bolt according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and particularly to FIGS. **1** and **2**, a preferred embodiment of the joint restraint of the present invention is shown and generally designated by the reference numeral **10**.

In a preferred embodiment, the joint restraint **10** is disposed on a first pipe **12** and comprises an annular body **14** through which the first pipe **12** passes and from which an annular projection **16** and a plurality of wedge housings **18** extend. A plurality of through holes **20** pass through the annular body **14** and are adapted to receive bolts extending from the flanged terminus of a second pipe (not shown) in the manner contemplated by the Sato '036 and Kennedy '175 patents.

In a preferred embodiment, the wedge housings **18** are uniformly distributed around the annular body **14** and the

joint restraint **10** is installed such that the wedge housings **18** extend away from the end **22** of the first pipe **12**.

Each wedge housing **18** comprises a top wall **24**, two side walls **26**, and a front wall **28**. The top wall **24** is the radially outer wall of the wedge housing **18** and the front wall **28** is the wall closest to the end **22** of the first pipe **12**. The top wall **24** of each wedge housing **18** comprises a hole **30** adapted to receive a bolt **32**. In a preferred embodiment and as shown in FIG. **2**, the hole **30** and bolt **32** are threaded so that bolt **32** may be threadedly engaged within hole **30**.

Each wedge housing **18** defines a wedge pocket **34** characterized by an open bottom **36** opposite the top wall **24** and an open rear face **38** opposite the front wall **28**. The use of an open rear face **38** rather than a rear wall allows the wedge housings **18** of the present invention to be cast without using cores.

Each wedge pocket **34** is adapted to receive a wedge **40**. The wedge **40** is held within the wedge pocket **34** such that when the joint restraint **10** is installed, the bottom **42** of the wedge **40** faces toward the outer surface **56** of the first pipe **12**, the top **44** of the wedge **40** faces the top wall **24** of the wedge housing **18**, the front surface **46** of the wedge **40** faces the front wall **28** of the wedge housing **18** and the rear surface **47** of the wedge is opposite the front surface **46**.

The top **44** of the wedge comprises a groove **48** adapted to slidably receive the end **50** of the bolt **32**. Preferably, the groove **48** has a slope that inclines from the rear surface **47** to the front surface **46** of the wedge **40**. In another preferred embodiment, the end **50** of the bolt **32** is flat-bottomed and in still other preferred embodiments suitable for high pressure service, the groove **48** has a slope as noted above and the end **50** of the bolt **32** is conical and preferably has a profile corresponding to the slope of the groove **48**.

The bottom **42** of the wedge **40** comprises two pipe-engaging teeth **52** and **54**, and in a preferred embodiment, both the bottom **42** and the teeth **52** and **54** are curved or arcuate to conform to the curvature of the surface **56** of the first pipe **12**. In a preferred embodiment, the first tooth **52** is disposed below the groove **48**. The second tooth **54** extends for a greater distance from the bottom **42** of the wedge **40** than the first tooth **52**, and is disposed between the first tooth **52** and the front **46** of the wedge **40**.

In a preferred embodiment, a shroud **60**, shown in FIGS. **3–9**, is employed to hold the wedges **40** in their respective wedge housings **18** and in the proper actuation location prior to installation of the joint restraint **10** on a pipe **12**. The shroud **60** preferably comprises a suitable material that allows the shroud **60** to snap fit as described below, and in order to allow flexing during actuation and operation of the joint restraint.

In a preferred embodiment, the shroud **60** forms a shell around the top **44** and sidewalls **62** of the wedge **40**. As shown in FIGS. **8** and **9**, the shroud **60** comprises upturned portions **64** and is secured to the wedge **40** by snapping the upturned portions around flanges **66** extending from the sidewalls **62** of the wedge **40**. In an alternate embodiment and as shown in FIG. **10**, the shroud **60** is secured to the wedge **40** by snapping the upturned portions **64** into grooves **67** disposed in the sidewalls **62** of the wedge **40**.

In a preferred embodiment, the top surface **68** of the shroud **60** comprises an aperture **70** into which the end **50** of the bolt **32** may be threaded. Alternatively, as shown in FIG. **11**, the bolt **32** may comprise a receiving groove **72** around which the aperture **70** of the shroud **60** snaps. In another alternate embodiment and as shown in FIG. **12**, the bolt **32** may comprise a flange **73** over which the aperture **70** of the shroud **60** is passed.

In addition, in a manner similar to that disclosed in Shumard '922, the bottoms of the sidewalls of the wedge housing pockets closest to the pipe have projections or grooves in the pocket area. In this embodiment, the shroud engages the projections or grooves to maintain the wedge in the wedge pocket.

In another preferred embodiment of the present invention, the end of the bolt is engaged with the wedge to keep the wedge from coming out of the open back of the wedge pocket. Also a mechanism may be incorporated into the shroud that allows the wedge to spring back into the joint restraint when the joint restraint is removed from the pipe.

In still another embodiment of the present invention, the shroud is engaged with the wedge, extends within the wedge housing pocket and has a portion that extends out of the wedge pocket and engages with the annular body to maintain the wedge in the wedge pocket.

In a still further embodiment of the present invention, a groove is disposed in the bottom of the wedges and a ring is placed within each groove that interacts with the walls of the wedge pocket to maintain each wedge in each wedge pocket.

Installation of the joint restraint **10** of the present invention comprises the actuation sequence shown in FIGS. **3–5**. For initial actuation, shown in FIG. **3**, the threaded bolt **32** is rotated or torqued into the wedge pocket **34** such that the end **50** of the bolt **32** moves radially inward towards the pipe surface **56** and is received within the groove **48** in the top **44** of the wedge **40**.

As shown in FIG. **4**, continued rotation or torquing of the bolt **32** drives the wedge **40** towards the pipe surface **56** such that the wedge **40** is eventually disposed between and in contact with the end **50** of the bolt **32** and the pipe surface **56**. The shroud **60** travels towards the pipe surface **56** with the bolt **32** and wedge **40**. As shown in FIG. **5**, with continued rotation or torquing of the bolt **32**, the first tooth **52** is driven into and penetrates the pipe surface **56**.

The second tooth **54** does not penetrate the pipe surface **56** during initial actuation because the force of the bolt **32** on the wedge **40** causes the wedge to pivot about an axis defined by the tooth **52** so that the bottom surface **42** of the wedge **40** between the first tooth **52** and the rear surface of the wedge **40** contacts the pipe surface **56**. If the second tooth **54** contacts the pipe surface **56** before the first tooth **52**, as shown in FIG. **4**, continued rotation or torquing of the bolt **32** will cause the wedge **50** to rotate or pivot about the second tooth **54** until the first tooth **52** contacts the pipe surface **56**. Preferably, the shroud **60** adapts to permit such rotation or pivoting to occur.

In a preferred embodiment of the present invention, the bottom surface **42** of the wedge **40** is tapered between the first tooth **52** and the rear surface **74** of the wedge **40** in order to form a bearing **76** that dissipates the actuation load of the bolt **32** on the wedge **40** over a relatively large area. After the first tooth **52** is fully embedded in the pipe surface **56**, the bearing **76** is seated against the pipe surface **56** such that over-torquing does not result in penetration of the second tooth **54** into the pipe surface **56**.

Those of ordinary skill in the art will recognize that the protection provided by the bearing **76** may be supplemented by using a torque wrench. Proper torquing and convenient installation of the wedge assemblies may also be ensured by providing a nut designed to shear at a predetermined torque (a "twist-off" nut).

An alternate bolt **84** employing a twist-off nut **86** is shown in FIG. **11**. The twist-off nut **86** of the alternate bolt **84** can be identical in structure and operation to the twist-off nut

disclosed in U.S. Pat. No. 4,627,774 to Bradley, the entire disclosure of which is incorporated herein by reference, with one exception: in the present invention, the thrust collar comprised by the Bradley device is unnecessary and is omitted.

Once the wedge **40** is actuated, motion of the first pipe **12** away from the second pipe, as occurs upon pressurization or other separation force, causes the first pipe **12** to shift relative to the annular body **14** and the bolt **32**. The sequence is shown in FIGS. **5–7**.

The connection between the annular body **14** and the flanged end of the second pipe is relatively rigid. As a result, the second pipe, annular body **14**, bolt **32**, and wedge housing **18** remain substantially stationary with respect to one another within the rated pressure of the joint restraint **10**. The wedge **40**, on the other hand, is embedded in the first pipe surface **56**, and accordingly tends to travel with the first pipe **12**.

As the wedge **40** begins to move with the pipe **12**, it slides with respect to the stationary bolt **32**, such that the bolt **32** moves relative to the groove **48** toward the front of the wedge **40**, as shown in FIG. **6**. The groove **48** is adapted to permit such relative motion within a certain range. Since the position of the bolt **32** is fixed, the sliding of the wedge **40** beneath the bolt **32** causes pivoting of the wedge **50** about the embedded first tooth **52**, especially in the preferred embodiment in which the groove **48** has an upward slope. As a result, the second tooth **54** is driven into the pipe surface **56**.

After the second tooth **54** is embedded in the pipe surface, further pivoting of the wedge **40** is inhibited, but the wedge **40** may still slide relative to the bolt **32** until interference with the front edge **78** of the groove **48** prevents further motion.

In a preferred embodiment, the front edge **78** of the groove **48** may comprise a raised lip **80** (shown in FIG. **8**) to increase the contact area with the bolt **32**, and, as is shown in FIGS. **8** and **9**, the shroud **60** may comprise an arch **82** adapted to accommodate the raised lip **80**.

Those of ordinary skill in the art will recognize that the joint restraint described above and shown in FIGS. **1–12** can be used in many other applications. For instance the joint restraint of the present invention can be used in conjunction with a plain ring to restrain a push-on joint in which the two rings are joined by connecting bolts. This type of application is similar to that disclosed in U.S. Pat. No. 4,336,959, the entire disclosure of which is incorporated herein by reference.

The joint restraint of the present invention can also be used in connection with a flanged pipe joint. Typically such flanges are fabricated as a part of the pipe. It is advantageous, at times, to cut pipe at a job location and be able to connect and restrain plain end pipe to a flange. The joint restraint of the present invention can be used to restrain this type of flange adapter in a manner similar to that described in U.S. Pat. No. 4,372,587, the entire disclosure of which is incorporated herein by reference.

While preferred embodiments of the invention have been shown and described, it will be understood by persons skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention which is defined by the following claims.

What is claimed is:

1. A joint restraint for restraining the junction between a first pipe and a second pipe, wherein said joint restraint comprises:

(a) a substantially annular body;

(b) a wedge housing extending axially from said annular body, said wedge housing comprising a front wall, a top wall extending from said front wall, and at least one side wall connected to said front and top walls, said at least one side wall together with said front wall defining a bottom opening opposite said top wall, and said at least one side wall together with said top wall defining a rear opening opposite said front wall, wherein said top wall has a hole opening into said wedge housing;

(c) a bolt having an end;

(d) means for engaging said bolt within said hole in said top wall of said wedge housing; and

(e) a wedge disposed within said wedge housing, said wedge comprising a front surface, a rear surface, a top surface and a bottom surface, said wedge further comprising at least one tooth extending from said bottom surface;

wherein said front surface of said wedge is adjacent said front wall of said wedge housing, said top surface of said wedge is adjacent said top wall of said wedge housing, and said end of said bolt is adjacent said top surface.

2. A joint restraint according to claim **1**, wherein said top surface of said wedge comprises a groove and said end of said bolt is slidably received within said groove.

3. A joint restraint according to claim **2**, wherein said groove has a slope that inclines from said rear surface of said wedge to said front surface of said wedge.

4. A joint restraint according to claim **2**, wherein a raised lip is disposed along a terminus of said groove adjacent said front surface.

5. A joint restraint according to claim **1**, wherein said bolt is threadedly engaged within said hole in said top wall of said wedge housing.

6. A joint restraint according to claim **1**, wherein said wedge comprises a first tooth and a second tooth extending from said bottom surface.

7. A joint restraint according to claim **6**, wherein said bottom surface, said first tooth and said second tooth are arcuate.

8. A joint restraint according to claim **6**, wherein said second tooth is disposed between said first tooth and said front surface.

9. A joint restraint according to claim **6**, wherein said second tooth is larger than said first tooth.

10. A joint restraint according to claim **6**, wherein said second tooth is smaller than said first tooth.

11. A joint restraint according to claim **6**, wherein said bottom surface of said wedge tapers toward said top surface between said first tooth and said rear surface.

12. A joint restraint according to claim **11**, wherein upon initial actuation of said bolt with respect to said wedge, said first tooth penetrates a pipe surface, wherein upon further actuation of said bolt with respect to said wedge, said wedge pivots about said first tooth until said tapered portion of said bottom surface is adjacent to said pipe surface.

13. A joint restraint according to claim **12**, wherein upon pressurization of said junction between said first pipe and said second pipe said wedge pivots about said first tooth until said second tooth penetrates said pipe surface.

14. A joint restraint according to claim **1**, wherein said bolt comprises a twist-off nut.

15. A joint restraint according to claim **1**, further comprising means for retaining said wedge within said wedge housing.

16. A joint restraint according to claim **15**, wherein said retaining means comprise a member adapted to receive and retain said wedge, said member having an aperture adapted to receive said end of said bolt.

17. A joint restraint according to claim **16**, wherein said bolt further comprises a groove for engaging said aperture of said member.

18. A joint restraint according to claim **16**, wherein said bolt further comprises a flange for engaging said aperture of said member.

19. A joint restraint according to claim **16**, wherein said bolt is threadedly engaged within said aperture of said member.

20. A joint restraint according to claim **16**, wherein said wedge further comprises two side surfaces each comprising a flange, and wherein said member is adapted to engage said flanges.

21. A joint restraint according to claim **16**, wherein said wedge further comprises two side surfaces each comprising a groove, and wherein said member is adapted to engage said grooves.

22. A joint restraint for restraining the junction between a first pipe and a second pipe, wherein said joint restraint comprises:

(a) a substantially annular body;

(b) a wedge housing extending axially from said annular body, said wedge housing comprising a front wall, a top wall extending from said front wall, and at least one side wall connected to said front and top walls, said at least one side wall together with said front wall defining a bottom opening opposite said top wall, and said at least one side wall together with said top wall defining a rear opening opposite said front wall, wherein said top wall has a hole opening into said wedge housing;

(c) a bolt having an end;

(d) means for engaging said bolt within said hole in said top wall of said wedge housing; and

(e) a wedge disposed within said wedge housing, said wedge comprising a front surface, a rear surface, a top surface and a bottom surface, said wedge further comprising a first tooth and a second tooth extending from said bottom surface;

wherein said second tooth is larger than said first tooth and is disposed between said first tooth and said front surface;

wherein said bottom surface tapers toward said top surface between said first tooth and said rear surface; and

wherein said front surface of said wedge is adjacent said front wall of said wedge housing, said top surface of said wedge is adjacent said top wall of said wedge housing, and said end of said bolt is engaged with said top surface of said wedge.

23. A joint restraint according to claim **22**, wherein said bolt is threadedly engaged within said hole in said top wall of said wedge housing.

24. A joint restraint according to claim **22**, wherein upon initial actuation of said bolt with respect to said wedge, said first tooth penetrates a pipe surface, wherein upon further actuation of said bolt with respect to said wedge, said wedge pivots about said first tooth until said tapered portion of said bottom surface is adjacent to said pipe surface.

25. A joint restraint according to claim **24**, wherein upon pressurization of said junction between said first pipe and said second pipe, said wedge pivots about said first tooth until said second tooth penetrates said pipe surface.

26. A joint restraint according to claim **22**, wherein said bottom surface, said first tooth and said second tooth are arcuate.

27. A joint restraint according to claim **22**, wherein said bolt comprises a twist-off nut.

28. A joint restraint according to claim **22**, further comprising means for retaining said wedge within said wedge housing.

29. A joint restraint according to claim **28**, wherein said retaining means comprise a member adapted to receive and retain said wedge, said member having an aperture adapted to receive said end of said bolt.

30. A joint restraint according to claim **29**, wherein said bolt further comprises a groove for engaging said aperture of said member.

31. A joint restraint according to claim **29**, wherein said bolt further comprises a flange for engaging said aperture of said member.

32. A joint restraint according to claim **29**, wherein said bolt is threadedly engaged within said aperture of said member.

33. A joint restraint according to claim **29**, wherein said wedge further comprises two side surfaces each comprising a flange, and wherein said member is adapted to engage said flanges.

34. A joint restraint according to claim **29**, wherein said wedge further comprises two side surfaces each comprising a groove, and wherein said member is adapted to engage said grooves.

35. A wedge for use in connection with a joint restraint, said wedge comprising:

(a) a front surface;

(b) a rear surface;

(c) a top surface;

(d) a bottom surface;

(e) a first tooth extending from said bottom surface; and

(f) a second tooth extending from said bottom surface;

wherein said bottom surface comprises a portion tapering toward said top surface between said first tooth and said rear surface, and wherein said second tooth is larger than said first tooth and is disposed between said first tooth and said front surface.

36. A wedge according to claim **35**, wherein upon initial bolt-driven actuation, said first tooth penetrates a pipe surface, wherein upon further bolt-driven actuation, said wedge pivots about said first tooth until said tapered portion of said bottom surface is adjacent to said pipe surface and wherein upon pressure-driven actuation said wedge pivots about said first tooth until said second tooth penetrates said pipe surface.

* * * * *

United States Patent [19]

Pannell et al.

[11] **Patent Number: 4,848,808**

[45] **Date of Patent: Jul. 18, 1989**

[54] **MECHANICAL PIPE JOINT**

[75] Inventors: **Minor W. Pannell; Alton L. Meadows**, both of Tyler, Tex.

[73] Assignee: **Tyler Pipe Industries, Inc.**, Tyler, Tex.

[21] Appl. No.: **248,098**

[22] Filed: **Sep. 23, 1988**

[51] **Int. Cl.**[4] **F16L 19/02**

[52] **U.S. Cl.** **285/337**; 285/374; 285/404; 285/4; 285/39

[58] **Field of Search** 285/337, 90, 404, 403, 285/382.7, 382, 4, 39

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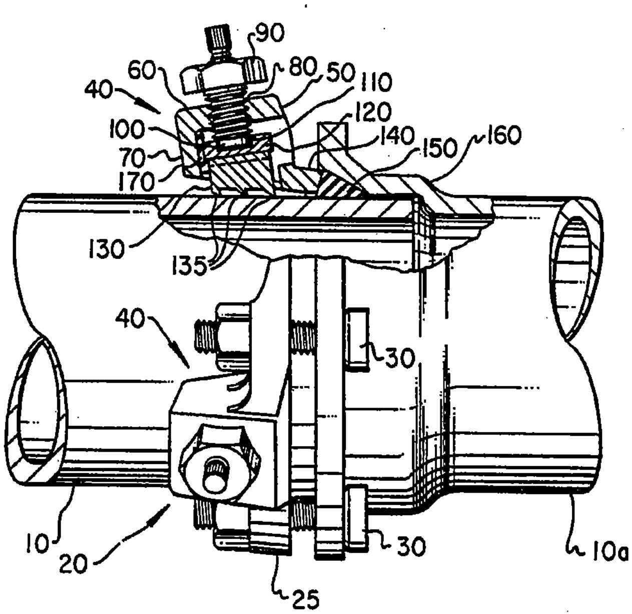
Assistant Examiner—P. Frechette
Attorney, Agent, or Firm—Michael A. O'Neil

[57] **ABSTRACT**

A mechanical pipe joint comprising a substantially cylindrical body integrally formed with a plurality of pipe restraining members, and a plurality of pipe clamping members, each comprising at least one block slidably engaged with a pipe restraining member, a compressible gasket for graduating suddenly applied forces, and restraining bolts. The clamping system, acting to distribute the clamping forces on a large portion of the surface area of a pipe, simultaneously absorbs and graduates suddenly applied forces, preventing failure of the pipe point.

7 Claims, 3 Drawing Sheets



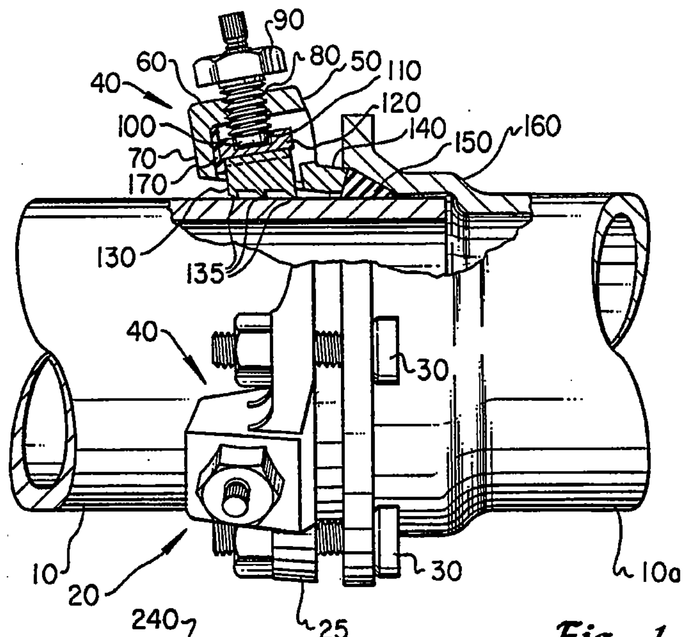


Fig. 1

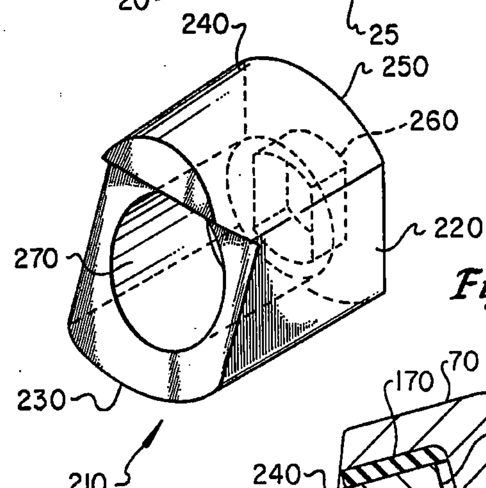


Fig. 6

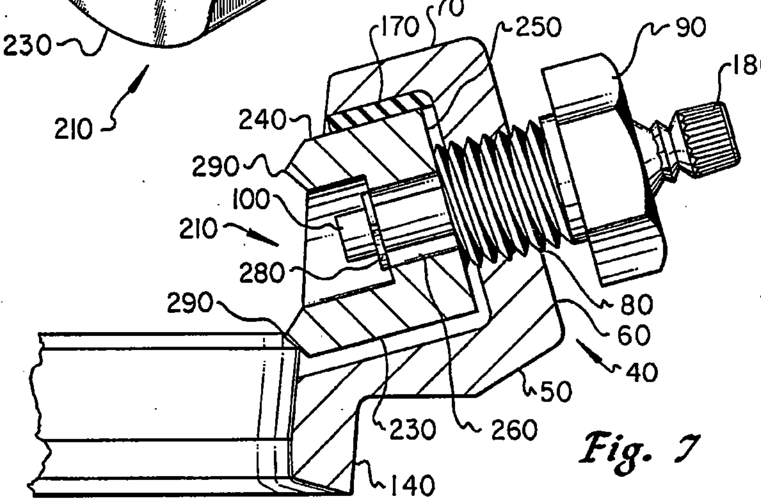


Fig. 7

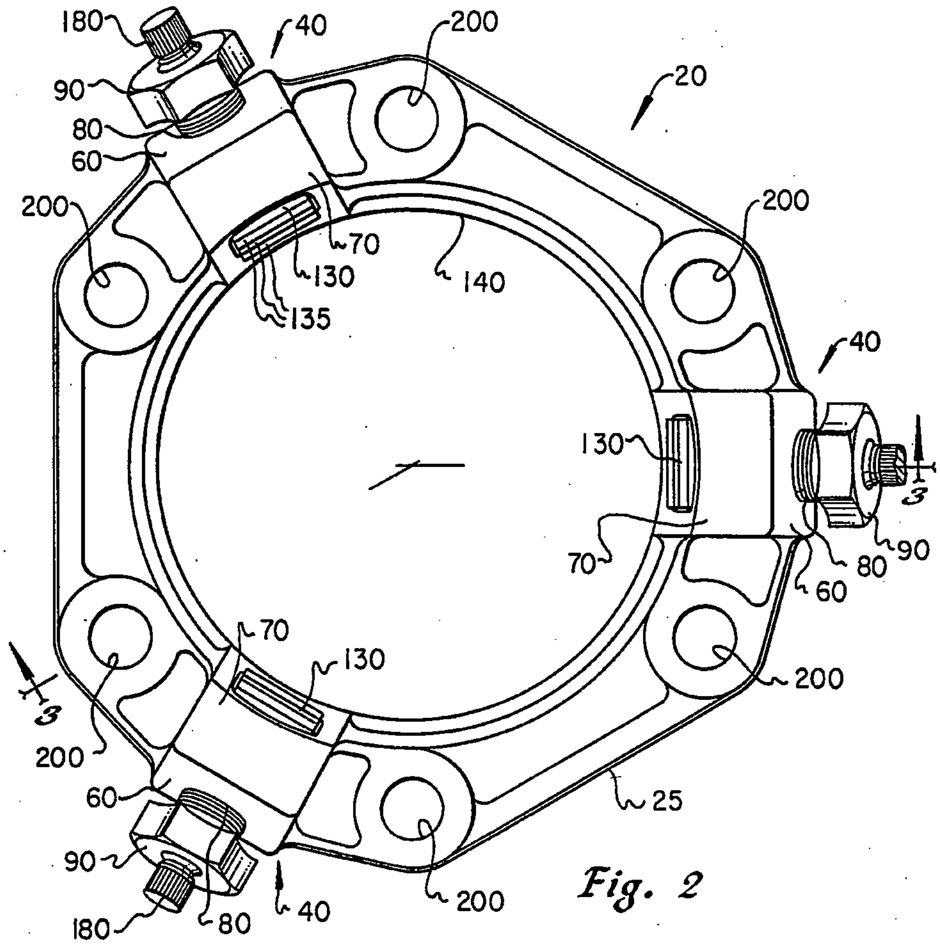

180
40
200
20
90
80
60
200
200
70
130
140
135
40
130
3
70
80
90
60
70
130
200
3
200
60
25
90
200
180
80
40

Fig. 2

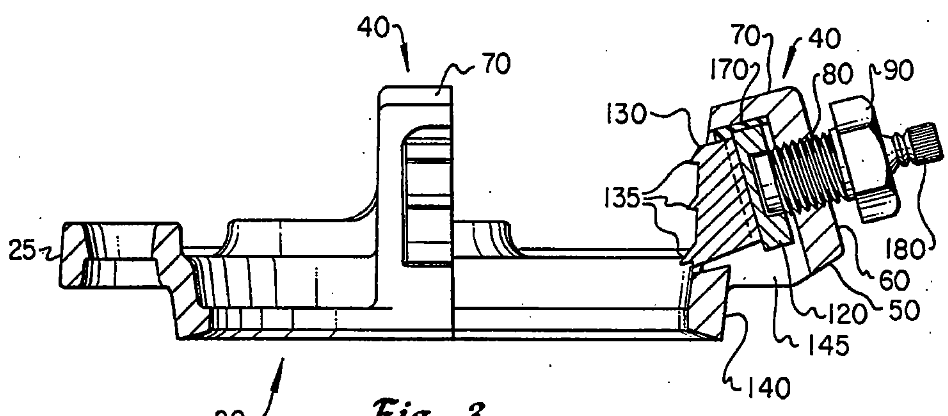

40
70
70
40
170
80
90
130
135
25
180
60
120
50
145
140
20

Fig. 3

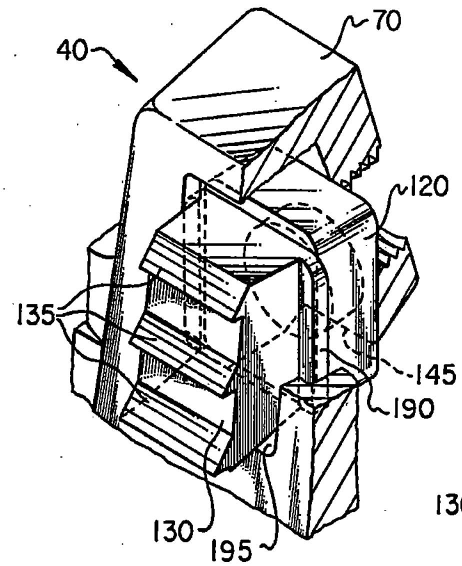


Fig. 4

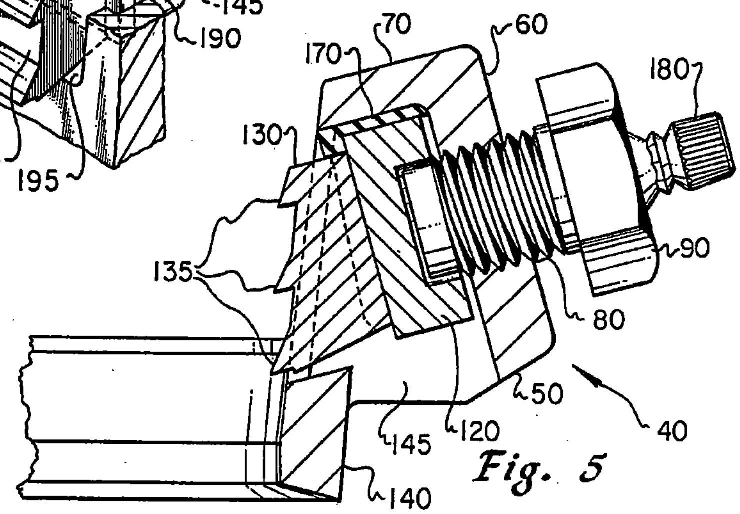


Fig. 5

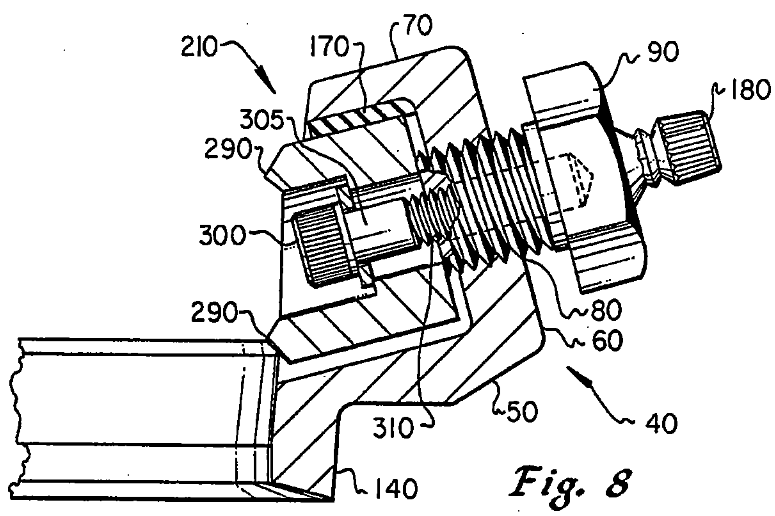


Fig. 8

MECHANICAL PIPE JOINT

TECHNICAL FIELD

The present invention relates to mechanical pipe joints, and more particularly to mechanical pipe joints utilizing pipe clamping systems.

BACKGROUND OF THE INVENTION

Currently, different types of mechanical pipe joints are used in the construction of pipelines carrying various fluids. These pipe joints, however, are susceptible to numerous failures for a number of reasons. Some prior art pipe joints, for example, use clamping devices such as bolts which contact a very small surface area on the exterior wall of the pipe. If the bolts are inadvertantly over-tightened, the bolts may penetrate or crack the wall of the pipe, thereby causing the pipe to leak. Alternatively, if the bolts are not strong enough, when the pipe joint is subjected to axial forces tending to pull the joint apart, the bolts will bend or break and the pipe joint will fail.

Other prior art pipe joints employ clamping devices designed to spread the clamping forced over a larger surface area of the pipe. While these pipe joints may succeed in distributing the clamping force over a larger surface area of the pipe, these devices make no provision for absorbing or graduating the effect of suddenly applied forces. A pipe joint can be subjected to massive forces occurring almost instantaneously. These forces may be the result of a rapid acceleration or deceleration of the rate of fluid flow through the pipe. For example, when a large valve on a high pressure water line is suddenly opened opened or closed, the axial forces resulting from the near-instantaneous acceleration or deceleration of the water in the pipe are almost instantly transmitted to the pipeline and subsequently the pipe joints. Prior art pipe joints subjected to these types of forces are subject to failure because such prior art mechanical pipe joints make no provision for absorbing or graduating these forces.

SUMMARY OF THE INVENTION

The present invention provides a mechanical pipe joint which alleviates the problems presented by prior art pipe joints. Particularly, the present invention provides a mechanical pipe joint which employs clamping means which spread clamping forces over a large portion of the surface area of the exterior wall of the pipe to be joined. The present invention also provides a mechanical pipe joint which is not susceptible to breakage resulting from the sudden application of forces to the pipe that are transmitted to the pipe joint.

The present invention is a mechanical pipe joint comprising a substantially cylindrical body defined by interior and exterior perimeters, the interior perimeter defining a central circular opening corresponding to the diameter of a first pipe upon which the pipe joint is mounted. The interior perimeter is formed into a tapered flange which fits into a flanged enlarged bell-shaped opening in a second pipe. A suitable packing is placed between the tapered flange and the second pipe in order to facilitate sealing the joint. The pipe joint is conventionally coupled to the second pipe by means of T-bolts passing through the through holes in the flange of the second pipe and through holes adjacent to the exterior perimeter of the mechanical pipe joint.

The pipe joint of the present invention is constructed with integrally formed pipe restraining members on the side of the joint opposite the flange of the second pipe. The pipe restraining members of the pipe joint of the present invention comprise a front wall formed by the substantially cylindrical body of the pipe joint, a slotted bottom wall, parallel sidewalls extending away from the front wall, a back wall and a top wall which is inclined away from the front wall. A threaded hole passes through the center of the top wall of the pipe restraining member at an angle perpendicular to the top wall.

A unique clamping system is used in conjunction with the pipe restraining members to clamp the pipe joint of the present invention onto the pipe. This unique clamping system distributes the clamping forces over a large surface area, while simultaneously providing means for absorbing or graduating the effect of suddenly applied forces. A substantially rectangular first block is slidably mounted in the slot in the bottom wall of the pipe restraining member on flanges extending along the sides of the block. The flanges on the first block prevent the block from falling through the slotted bottom wall of the pipe restraining member after initial assembly and prior to installation. The portion of the first block extending from the slot in the bottom wall of the pipe restraining member is formed into multiple inclined wedge shaped teeth that engage the pipe wall when the mechanical pipe joint is installed.

A second block is slidably mounted within the pipe restraining member on top of the first block. The second block is a substantially rectangular block formed with a non-threaded hole in the top of the block. The non-threaded hole is perpendicular to the top of the block and passes partially through the block. A compressible gasket is positioned between the back wall of the pipe restraining member and the first and second blocks. A restraining bolt is threadably engaged in the threaded hole in the top wall of the pipe restraining member. A non-threaded portion of the shank of the restraining bolt is fitted into the hole in the top of the second block. Thus, when the restraining bolt is tightened, the force generated is transmitted through the blocks, causing the teeth of the first block to engage the exterior wall of a pipe.

This unique combination of clamping elements, comprising a restraining bolt, first and second blocks, and a compressible gasket securely holds the pipes in position while simultaneously providing a means for graduating or absorbing forces which are suddenly applied to the pipes and consequently transmitted to the pipe joint. When an axial force tending to pull the pipes apart is suddenly applied, the teeth of the first block, being inclined relative to the outside wall of the pipe, tend to bit deeper into the pipe. Simultaneously, the first block may slide along the second block against the compressible gasket. The compressible gasket in turn graduates and absorbs the sudden forces applied, thereby preventing the breakage of any of the components of the clamping system or the pipe restraining member.

A second embodiment of the clamping system of the mechanical pipe joint of the present invention substitutes a one-piece pipe restraining block for the first and second blocks described earlier. The one-piece pipe restraining block comprises a hollow block, open-ended on the front side, with a non-threaded, elliptical hole in the back wall of the block. The ends of the top and bottom walls opposite the back wall of the one-piece pipe restraining block are formed into pipe restraining

teeth. The one-piece pipe restraining block is slidably retained within a pipe restraining member on a non-threaded portion of the shank of a restraining bolt.

A compressible gasket is positioned between the one-piece pipe restraining block and the back wall of the pipe restraining member. When an axial force tending to pull the pipes apart is suddenly applied, the teeth of the one-piece pipe restraining block tend to bite into the exterior wall of the pipe. Since the hole in the back wall of the one-piece pipe restraining block is elliptical, the one-piece block may slide toward the back wall of the pipe restraining member when a sudden force is applied, transmitting the force to the compressible gasket. The compresssible gasket, in turn, graduates or absorbs the forces transmitted to it by the one-piece pipe restraining block, thereby preventing breakage of any of the components of the clamping system or the pipe restraining member.

The mechanical pipe joint of the present invention is superior to the prior art in that it provides a clamping system over a large surface area and also provides means for absorbing and graduating suddenly applied forces which might otherwise break one or more components of the pipe joint. Other objects, features and advantages of the present invention will become apparent from the Detailed Description given herein; it should be understood, however, that the Detailed Description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from the Detailed Description.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention and its advantages will be apparent from the Detailed Description taken in conjunction with the accompanying Drawings, in which:

FIG. 1 is a partial sectional view of the pipe joint of the present invention installed on two joined pipes.

FIG. 2 is an end view of the pipe joint of FIG. 1.

FIG. 3 is a sectional view taken along lines 3—3 of FIG. 2.

FIG. 4 is an exploded perspective view of a multi-component pipe clamping system used in the present invention.

FIG. 5 is a sectional view of the pipe restraining member of the present invention further illustrating the clamping system.

FIG. 6 is a perspective view of a one-piece pipe restraining block.

FIG. 7 is a sectional view of a second embodiment of the present invention in which a one-piece pipe restraining block is retained on a restraining bolt by means of a snap ring.

FIG. 8 is a sectional view of a third embodiment of the present invention in which a one-piece pipe restraining block is retained on the restraining bolt by means of a threaded screw.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring now to FIG. 1, a mechanical pipe joint 20 incorporating the present invention is shown installed on pipes 10 and 10A. The pipe joint 20 comprises a substantially cylindrical body 25 shown joining pipes 10 and 10A by means of T-bolts 30 and pipe restraining members 40. The pipe restraining member 40 comprises a front wall 50, a top wall 60, and a back wall 70. The top wall 60 has a centrally located threaded hole 80 which is perpendicular to the top wall 60. A first block 130 is slidably mounted in pipe restraining member 40 and has pipe engaging teeth 135. A second block 120 is slidably engaged with the top of the first block 130, and has a centrally located non-threaded hole 110 engaged by a non-threaded portion 100 of the shank of a restraining bolt 90. The leading edge of the cylindrical body 25 is formed into a tapered flange 140 which compresses a packing 150 positioned between first pipe 10 and the enlarged bell-shaped section 160 of the second pipe 10A.

The pipe joint of the present invention is installed as illustrated in FIG. 1 so that the parts are positioned approximately as shown in FIG. 1. In the event that pipes 10 and 10A are subjected to a force tending to disjoint the ends of the pipes 10 and 10A, the teeth 135 resist the movement of pipe 10 by biting into the exterior wall of pipe 10. The teeth 135 tend to bite more deeply into the exterior wall of the pipe and resist movement of the pipe as the disjointing force is increased.

Referring to FIGS. 1 and 3, pipe restraining member 40 would ordinarily be subject to breakage upon a sudden application of disjointing force to the pipes 10 and 10A. However, the pipe restraining member 40 is protected from sudden shock by the unique combination of first slidably mounted block 130, second block 120 slidably engaged with first block 130, and compressible gasket 170. When a sudden force is applied, the first block 130, being independent of the second block 120 and the restraining bolt 90, may slide along the face of second block 120 and against the compressible gasket 170, thereby graduating the effect of the sudden application of force. The compressible gasket 170 also tends to graduate any application of force to the second block 120 resulting from sudden forces acting on the pipes 10 and 10A.

FIG. 2 is an end view of the pipe joint 20 showing the relative positions of pipe restraining members 40 and non-threaded T-bolt through holes 200. The restraining bolts 90 have splined twist-off lugs 180. The splined twist-off lugs 180 are designed to break off of the restraining bolt 90 upon the application of a predetermined torque. Thus, by applying a suitable wrench to the twist-off lugs 180, and tightening the restraining bolts 90 until the twist-off lug 180 breaks off, the restraining bolts 90 are tightened to the proper torque.

FIG. 3 is a sectional drawing taken along lines 3 illustrated in FIG. 2. FIG. 3 further illustrates the relative position of the first block 130, second block 120, and compressible gasket 170, within the pipe restraining member 40.

FIG. 4 illustrates the means retaining first block 130 in pipe restraining member 40 after initial assembly and prior to installation. First block 130 is shown with retaining flange 190. Pipe restraining member 40 is illustrated with slotted bottom wall 195. When first block 130 is inserted into the pipe restraining member 40, retaining flanges 190 and slotted bottom wall 195 cooperate to retain first block 130 in pipe restraining member 40.

Referring now to FIGS. 3 and 5, FIG. 5 is an enlarged sectional view of pipe restraining member 40 further illustrating the relative positions of first block 130, second block 120, and compressible gasket 170.

First block 130 and second block 120 are installed in the pipe restraining member 40 by inserting the blocks through receiving hole 145.

FIG. 6 illustrates an alternate one-piece embodiment of first block 130 and second block 120 of the previous figures. The one-piece block 210 is shown in FIG. 6 with parallel side walls 220, bottom wall 230, top wall 240, and back wall 250. The back wall 250 is formed with an elliptical hole 260, which is smaller in diameter than the internal opening 270 defined by the side walls 220, top wall 240, and bottom wall 230.

FIG. 7 is a sectional drawing which illustrates a second embodiment of the invention wherein the one-piece block 210 of FIG. 6 is slidably mounted within a pipe restraining member 40. The non-threaded portion 100 of the shank of the restraining bolt 90 extends through elliptical hole 260 in the back wall 250 of the one-piece block 210. The one-piece block 210 is retained on the non-threaded portion 100 of the shank of the restraining bolt 90 by means of a snap ring 280. The top wall 240 and the bottom wall 230 of the one-piece block 210 are formed into pipe engaging teeth 290 at their respective ends. Thus, when a sudden force is applied to one-piece pipe block 210, elliptical hole 260 allows one-piece block 210 to slide against compressible gasket 170, thereby graduating the effect of the sudden force.

FIG. 8 is a sectional view which illustrates a third embodiment of the invention wherein the one-piece block 210 is slidably mounted within a pipe restraining member 40 upon non-threaded portion 305 of the shank of socket head cap screw 300. The socket head cap screw 300 is threadably engaged in threaded hole 310 in the shank of the restraining bolt 90.

While the invention has been described in connection with the illustrated embodiments, it is not intended to limit the scope of the invention to the particular forms set forth, but, on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined in the appended claims.

We claim:

1. A mechanical pipe joint comprising:

a substantially cylindrical collar surrounding a pipe;

a plurality of circumferentially spaced pipe restraining members, integrally formed with said collar and extending parallel to the longitudinal axis of said pipe from one end of said collar;

each of said pipe restraining members comprising a central cavity opening toward said pipe, said cavity defined by a top wall, a front wall, a back wall and side walls, each of said top walls being formed with a threaded aperture;

at least one block being slidably supported in each of said central cavities;

a plurality of restraining bolts, each threadably engaging said threaded aperture and non-threadably engaging said block, said restraining bolt cooperating with at least one block to forcibly cause said at least one block to engage said pipe;

means permitting predetermined limited longitudinal movement of said block relative to said restraining bolt and said central cavity to accommodate movement; and

resilient cushioning means interposed between said block and said pipe restraining member.

2. A mechanical pipe joint in accordance with claim 1 wherein said pipe restraining member is formed with a slotted bottom wall.

3. A mechanical pipe joint in accordance with claim 1, further comprising slidably engaging first and second blocks, said first block formed with pipe engaging teeth, said second block non-threadably engaging said restraining bolt.

4. A mechanical pipe joint in accordance with claim 1 wherein said pipe restraining bolt is formed with a threaded and non-threaded shank portion, said non-threaded shank portion being slidably engaged with at least one block in each of said pipe restraining members.

5. A mechanical pipe joint in accordance with claim 1 wherein the shank of said pipe restraining bolt is formed with a longitudinally extending interior threaded hole, said interior hole being threadably engaged by a second bolt comprising a threaded and non-threaded shank portion, said non-threaded shank portion of said second bolt being slidably engaged with at least one block in each of said pipe restraining members.

6. A mechanical pipe joint in accordance with claim 1 wherein a single block forms pipe engaging teeth, said single block being slidably supported on said restraining bolt within each of said pipe restraining members.

7. A mechanical pipe joint comprising:

a substantially cylindrical collar surrounding a pipe;

a plurality of circumferentially spaced pipe restraining members, integrally formed with said collar and extending parallel to the longitudinal axis of said pipe from one end of said collar;

each of said pipe restraining members comprising a rectangular central cavity opening toward said pipe, said cavity defined by a top wall, a front wall, a back wall, parallel side walls and a slotted bottom wall, said top wall being formed with a threaded aperture;

a first block, slidably supported in said slotted bottom wall of each of said pipe restraining members;

a second block, slidably mated to said first block within said central cavity in each of said pipe restraining members;

a plurality of restraining bolts, each threadably engaging said threaded aperture and non-threadably engaging said second block, said restraining bolt cooperating with said first and second block to forcibly cause said first block to engage said pipe;

means permitting predetermined limited longitudinal movement of said first block relative to said restraining bolt and said rectangular cavity; and

a plurality of resilient cushioning means interposed between each of said pipe restraining members and said first and second blocks.

* * * * *

RELATED PROCEEDINGS APPENDIX

(None)